Instruction Book

SELEKTOMAT

Type USWV

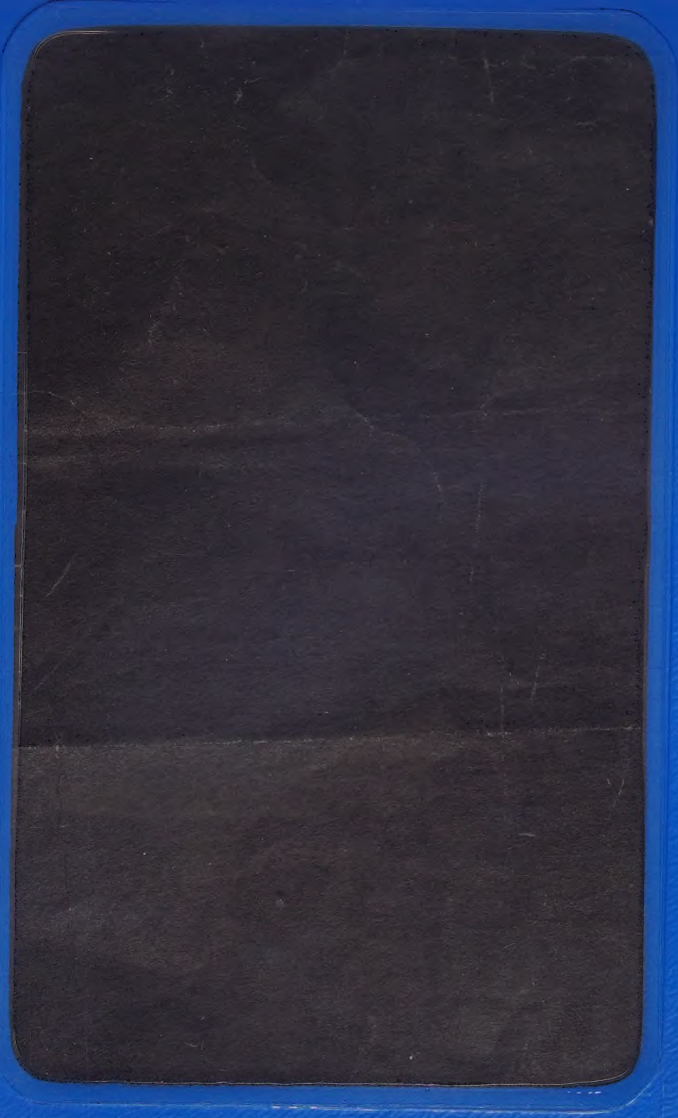
BN 15221/50 BN 15221/60

CHECKED JUN 10 1971

ROHDE & SCHWARZ SALES CO. (U.S.A.) INC.
111 LEXINGTON AVENUE

MP MASTER
MA22478

ROHDE & SCHWARZ



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Note: Always quote the Type and Order Number (BN) in addition to the Serial Number (FNr.) of the set when asking for technical information and, in particular, when ordering repair parts.

Edition R 7493/961

(Translation of the German edition R 7456/861)

S U P P L E M E N T

to the Instruction Book R 7493/961 for the

SELEKTOMAT Type USWV BN 15221/..

referring to the instruments with the serial numbers F 1471/1 to 100

Supplement to Section 3.2.1 on page 11, below:

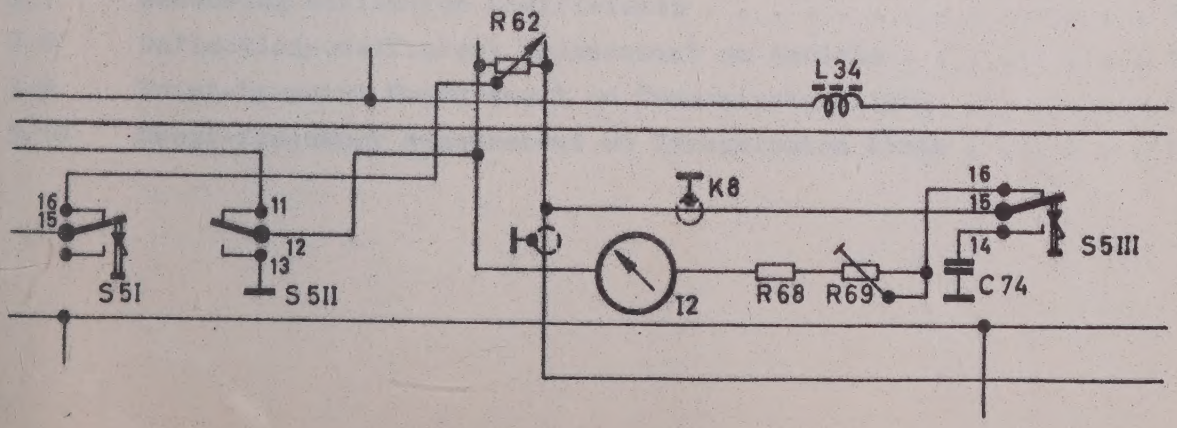
In linear measurements at full gain the measured value displayed on the screen contains a noise component (approx. 2 to 5 mm noise deflection). A noisefree pattern is obtained if you increase the input voltage of the Selektomat (output attenuator of Polyskop or input attenuator of Selektomat) and adjust for the same display height using the gain control. This results in a more favourable signal-to-noise ratio but entails a reduction of the sensitivity of the Selektomat by the factor of the decrease in gain.

Changes in the Table of Replaceable Parts

C15	Capacitor, ceramic	5 pf	CCG 68/5
C74	Capacitor, ceramic	2200 pf	CCG 94/2200
G115	Diode		GK/Si 3
G116	Diode		GK/Si 3
G117	Diode		GK/Si 3
R34	Resistor, depos. carbon	10 kΩ/0.1 w	WF 10 k/0,1
R38	Resistor, depos. carbon	10 kΩ/0.1 w	WF 10 k/0,1
R65	Resistor, depos. carbon	50 kΩ/0.25 w	WF 50 k/0,25
R124	Resistor, depos. carbon	200 kΩ/0.25 w	WF 200 k/0,25
R131	Resistor, depos. carbon	16 kΩ/0.5 w	WF 16 k/0,5
R167	Resistor, depos. carbon	40 kΩ/0.5 w	WF 40 k/0,5

Modifications to the Circuit Diagram on page 65

Switch S5II with the contacts 11-12-13 and capacitor C74 at S5III-14-15-16 have been added.



Supplement Edition R 7774/662

Translation of the German edition R 7757/662

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1. Short General Description

The SELEKTOMAT is a measuring receiver with an electronically-tuned local oscillator. The input signal passes via an attenuator to a broadband mixer where it is converted to the intermediate frequency. A switch permits linear or logarithmic IF amplification to be selected. Amplitude and frequency of the signal are indicated on panel meters.

Tuning can be made by hand, as on a conventional measuring receiver, or automatically. The automatic scanning circuit, the automatic gain control and the automatic frequency tracking permit scanning of and tuning to the input signal as well as inertia-free tracking of a changing frequency. Thus no operating controls need be manipulated during the measuring procedure.

The fact that a changing frequency can be tracked makes it also possible to use the SELEKTOMAT in conjunction with a POLYSKOP for direct linear or logarithmic representation of the frequency response of a test item. To this end, the SELEKTOMAT delivers two output voltages: the measured voltage and a variable calibrated reference voltage (reference line) which permits no-parallax amplitude measurement on the screen of the POLYSKOP.

Use the SELEKTOMAT to make frequency-response meaasurements on 2- and 4-terminal networks of all kinds, e.g. for measurement of the far-off selectivity of filters and amplifiers; measurement of the input reflection of 4-terminal networks (with a reflectometer); measurement on broadband modulators (modulation depth, upper and lower sidebands), and the like; measurement of the reflection coefficient of aerials (with a reflectometer).

All measurements can be made either point by point with a suitable signal generator or by the swept-frequency method using the POLYSKOP.

Fig. 1 indicates the characteristics of the SELEKTOMAT as well as the locations of the outer connections and control knobs. Section 4 contains further information on the technical characteristics and the recommended accessories.

2. Operating Instructions

2.1 Preparation for Use

The SELEKTOMAT leaves our factory adjusted for operation from 220 v AC. To adjust it for 115 v, 125 v or 235 v, remove the chassis from its cabinet and insert the proper fuse into the clips marked on the fuse panel to correspond with the local AC supply voltage. The fuse panel is located above the power transformer. The fuse rating is 1 amp for 220 and 235 v, 2 amps for 115 and 125 v.

The power cord LK 333 supplied with the set is connected to the rear of the SELEKTOMAT.

Put the power switch (7) of the SELEKTOMAT up for on. The pilot lamp (6) indicates that voltage is applied to the set. Allow a few minutes for warming up.

2.2 Calibration of Gain

The SELEKTOMAT comprises a calibration oscillator which delivers a constant voltage at a frequency of about 35 Mc. This voltage is fed to the mixer of the SELEKTOMAT and serves to calibrate the gain of the set. Under the flap, there are switch (13) for the calibration oscillator and control (14) for the gain. After the calibration oscillator has been switched on, set the input attenuator (24) to -60 db. Leave the Dezifix input (19) open. Set the frequency range switch, (18), at 30 - 60 MC and press buttons (23) AUTOMAT., (10) METER and (15) LOG. or (16) LIN. Set the TRACKING switch (17) to ON.

Meter (1) for frequency indication will indicate, after a few oscillations of the pointer, the calibration frequency identified by a red mark. The pointer of meter (3) for amplitude indication will come to a standstill near -60 db (red mark) in logarithmic operation and near 0 db (red mark) in linear operation. The gain can then be adjusted to the nominal value for logarithmic or linear operation. After the adjustment has been completed, switch the calibration oscillator off. The SELEKTOMAT is then ready for operation.

2.3 Selecting the Type of Operation

Using the 6 buttons select the type of operation necessary for the measurement.

2.3.1 MANUAL and AUTOMAT. Types of Operation

The buttons (22) and (23) permit the SELEKTOMAT to be tuned automatically or manually to the test signal. Pressing the MANUAL button (22) you can tune the SELEKTOMAT in the same way as any conventional selective measuring receiver. The COARSE (21) and FINE (20) controls serve to tune to the frequency. Meter (1) for frequency indication has 7 scales corresponding with the 7 sub-ranges of the range switch (18). Find the desired signal by slowly rotating the COARSE control. For accurate tuning use the FINE control.

2.3.2 LOG. and LIN. Types of Operation

With the LOG. button (15) depressed the SELEKTOMAT has a logarithmic gain over a range of 80 db; if the LIN. button (16) is pressed, the gain is linear over 21 db.

2.3.3 METER and POLYSKOP Types of Operation

Use button (10) for a point-by-point measurement with amplitude indication on the panel meter (3) or button (11) for a swept-frequency measurement on an oscilloscope (POLYSKOP). The output sockets and controls on the right-hand side of the front panel of the SELEKTOMAT are used only in swept-frequency measurements. The SIGNAL OUTPUT (9) delivers a voltage corresponding to the amplitude characteristic of the test item, while the REF. LINE output (8) delivers a reference voltage which is calibrated and adjustable by means of the dial (4). The CALIBRATE button (5) serves to obtain exactly equal gains in order to ensure an accurate relationship between the signal level and the reference line.

2.4 NOT TUNED Operation

Pilot lamp (2) between the two meters lights up when the SELEKTOMAT is not tuned to a signal.

2.5 Start of Tracking

In a swept-frequency measurement, adjust the frequency where tracking starts near the left-hand edge of the screen, using the START OF TRACKING control (12). In point-by-point measurements this control is not used.

3. Examples of Measurement

The operation of the SELEKTOMAT is best understood by referring to a few typical examples.

3.1 Point-by-point Measurement on a 4-terminal Network (see Fig. 3)

Feed the test item from a signal generator, such as the Type SMLM, and connect its output via a cable to the input of the SELEKTOMAT.

3.1.1 Operation without Automatic Features

Basic settings: Set input attenuator to -10 db, frequency range switch to suitable range, TRACKING switch to OFF and press the buttons MANUAL, LOG. and METER. Find the signal with the TUNING knobs (21) and (20); turn the COARSE knob slowly to be sure that the signal is found in spite of the narrow bandwidth of the IF amplifier. The SELEKTOMAT is not immune from image frequencies in this type of operation. Every signal is measured again at a distance of twice the IF = 2 x 10.5 Mc = 21 Mc. Note that in the logarithmic range an input signal as low as 1 µv is indicated. External interference voltages of this order of magnitude may leak in via the test item or defective cable connections and thus make it difficult to find the signal. For easier distinction it is advisable to switch over to linear indication and to reduce the sensitivity of the SELEKTOMAT by means of the input attenuator so far that the signal just produces a sufficient meter deflection. During the measurement, the SELEKTOMAT must be retuned manually after each variation of the test frequency. Furthermore it cannot be expected that a signal once tuned in remains in the reception range for any period of time, since the frequency stability of the electronically controlled local oscillator is not high enough.

3.1.2 Putting the TRACKING Switch to ON

When the TRACKING switch (17) is at ON, manual adjustment of the SELEKTOMAT to the test signal is replaced by automatic tracking and any variation of the test frequency is permissible within the limits of the reception range selected. The COARSE TUNING control (21) must in this case be turned fully counterclockwise in order to enable the automatic tracking circuit to tune the set over the entire sub-range.

When tracking is selected the SELEKTOMAT becomes immune from image frequencies and reception is maintained only if the local oscillator operates above the test frequency. Otherwise the declining amplitude indication would show that the image frequency has been adjusted for. If the signal generator is disconnected from the test item for a short time, e.g. by operating the input attenuator of the SELEKTOMAT, which may interrupt in its intermediate positions, or by changing the range of the signal generator, then the SELEKTOMAT goes off tune and the pilot lamp (2) lights. A new adjustment to the test frequency must then be made.

The functioning of the SELEKTOMAT requires that manual tuning is always made beginning from the low frequencies towards the high ones if tracking is selected. When tuning from high frequencies towards lower ones the tracking circuit locks to the first received signal and the tuning cannot be adjusted to lower frequencies by means of control (21).

3.1.3 Automatic Operation

Basic settings: Same as described in 3.1.1, but press the AUTOMAT. instead of the MANUAL button. Instead of the frequency tuning with the COARSE and FINE controls the tuning is now made by the automatic signal-seeking circuit and automatic gain control. The pointer of the frequency indicator, on the left, oscillates several times (once a second) over the full scale. In logarithmic operation the pointer of the right-hand meter (amplitude indication) goes once to the right stop and returns to the left stop in about 10 seconds. The pilot lamp (2) lights up. After a few seconds the lamp goes out, the left-hand meter indicates the frequency to which the SELEKTOMAT has been tuned automatically, and the right-hand meter indicates the amplitude. During these few seconds, the automatic gain control has weighted all input signals with respect to their amplitude and the SELEKTOMAT has locked to the strongest signal. This tuning is maintained

even if the frequency of the signal varies. After any short interruption the signal-seeking process commences again. For example, retuning is ensured within a few seconds when the range of the signal generator is switched over. Check the frequency indication to see whether the tuning agrees with the signal-generator frequency, taking into account the accuracy of frequency indication. Particularly in logarithmic operation tuning to harmonics or spurious frequencies may be possible. In this case, disable the tracking action for a short time, then switch it on again and repeat the signal-seeking process. With linear amplification, the automatic gain control is not shown by the deflection of the right-hand meter. The pointer remains in its zero position as long as the signal-seeking process continues. The SELEKTOMAT indicates the measured value after tuning has been completed.

Using the method described, any active and passive 4-terminal networks can be measured. The input frequency need not be equal to the output frequency. For example, a receiver may be fed by an RF signal whereas the SELEKTOMAT measures the IF voltage at the output of the IF amplifier. Harmonics of the test frequency may also be measured.

.1.4 Drop of Signal Voltage Below 10 µv

The sensitivity of the SELEKTOMAT is 10 µv. If in a point-by-point measurement the input voltage of the SELEKTOMAT drops below this value, the automatic tuning does not work. This condition becomes obvious when the pilot lamp (2) lights and the pointer of the frequency meter oscillates. If it is impossible to obtain more than 10 µv by increasing the signal-generator output, slowly change the test frequency until the signal voltage is sufficient and the SELEKTOMAT can tune again.

.1.5 Overdriving

If an RF signal of more than 100 mv is applied to the mixer of the SELEKTOMAT its operation may be disturbed by overdriving of the mixer. The automatic tuning may then respond to harmonics or cross-modulation products. The resistors of the input attenuator do not withstand RF voltages that are considerably higher than 1 v. Higher input voltages must be reduced by suitably rated attenuator pads before being applied to the input of the SELEKTOMAT.

3.2 The SELEKTOMAT Used as Preamplifier for the POLYSKOP

The sensitivity obtainable with the POLYSKOP is governed by the broadband diode rectifier circuits in its diode probes. RF signals of the order of 0 mv can be measured satisfactorily with the POLYSKOP without accessory equipment. Because of the non-linearity of the rectifier diodes the display on the POLYSKOP screen is not proportional to the voltage. Thus it s not possible to judge the level differences directly. A level measurement must be made by comparison, using the POLYSKOP attenuators.

The SELEKTOMAT offers the possibility of increasing the sensitivity of the POLYSKOP by about 60 db, by amplifying the RF signals derived from the test item. The SELEKTOMAT tracks the swept frequency of the POLYSKOP and transposes it to a narrow-band IF, thus providing for a high gain which may be linear or cover 30 db logarithmically. At the signal output a rectified voltage proportional to the attenuation characteristic of the test item is available. The reference-line output delivers a reference voltage, variable in calibrated attenuation values, which appears in dual-trace display on the POLYSKOP screen together with the measured value and ensures high accuracy of the amplitude measurement.

3.2.1 Test Assembly (see Fig. 4)

Connect the SIGNAL OUTPUT (9) to the left-hand AF input of the POLYSKOP and the REF. LINE output (8) to the right-hand AF input, using the two short cables supplied with the SELEKTOMAT. Insert the test item between the RF output of the POLYSKOP and the RF input of the SELEKTOMAT.

For first-time operation, proceed as follows: Connect the RF output of the POLYSKOP directly to the RF input of the SELEKTOMAT without inserting the test item. Select the frequency range and sweep width on the POLYSKOP. The output attenuator should be at 10 db.

Set the SELEKTOMAT as follows: Tracking OFF, input attenuator -20 db; press the buttons MANUAL, LOG., and POLYSKOP.

Make the following settings on the POLYSKOP: Function selector Y_1 to EXT.; turn vertical-gain controls Y_1 and Y_2 clockwise about 1/3 of the way. The trace displayed on the POLYSKOP is shown in Fig. 5. By varying the tuning control (21) two narrow curves can be displayed. The left-hand curve (f_1) is the passband characteristic of the SELEKTOMAT while the local oscillator

perates above the reception frequency: the right-hand curve (f_2) appears t a distance of twice the IF (2 x 10.5 Mc = 21 Mc) and is the image frequency. Adjust the frequency on the SELEKTOMAT so that curve f_1 closely approaches the left-hand edge of the screen. Put the TRACKING switch to N. Beginning from the selected frequency f_1, the SELEKTOMAT tracks up to he right-hand edge of the screen and produces a straight line as shown y the dotted line in Fig. 5. The second curve at f_2 disappears when the racking circuit is switched on.

djust the two deflection amplifiers in the POLYSKOP for equal sensitivty. Press the CALIBRATE button (5) and adjust the vertical-gain controls f the POLYSKOP so that the displayed curves coincide on line 10 of the ransparent chart. Make this adjustment while the reference-line adjustent (4) is at 0 db. Leave the vertical-gain controls of the POLYSKOP in he same position for all further measurements; do not change their settings. Only under this condition will the accurate relationship between he reference line and the measured value be maintained. If a variation f the picture height is desired, it must be achieved with the attenuaors of the POLYSKOP or of the SELEKTOMAT; small corrections may be made ith the gain knob (14) of the SELEKTOMAT.

n this short-circuit measurement, the accuracy of the reference-line alibration may be checked by alternately varying the input attenuator and he reference-line adjustment.

fter the test assembly has been checked in the short circuit condition, onnect the test item between the POLYSKOP and the SELEKTOMAT. If the test em is a passive 4-terminal network, there is no risk of overdriving the LEKTOMAT. For the measurement of amplifiers it is advisable first to t the input attenuator of the SELEKTOMAT to -60 db and to reduce the tenuation only so far that a suitable picture height is obtained.

2.2 Failure to Track

acking is ensured only as long as the input voltage at the mixer of the LEKTOMAT is greater than 10 µv. If the test item has a very high attention, it is possible that within the swept range the attenuation becomes high that the output voltage of the test item is no longer sufficient maintain tracking. The POLYSKOP then displays a trace as shown in Fig. Failure to track becomes evident by the fact that the reference line

ends at the same point where the measured value drops to the zero line. Erroneous measurements can thus definitely be avoided. The design of the SELEKTOMAT does not provide for the possibility that in this case tracking starts again at a higher frequency where a higher signal voltage may be available again. The measurement must then be made in two steps, one going up to the attenuation maximum and the second from the maximum to the end of the range (see Fig. 7). In logarithmic operation the dynamic range of 80 db should be sufficient to permit measurement in one step even if the test item has high attenuation. In linear operation the signal voltage must not vary by more than 20 db, otherwise tracking may not be maintained over the entire range. Test items that vary considerably in attenuation can be measured only stepwise in linear operation.

Failure to track may also be due to the frequency-marker oscillators of the POLYSKOP. Although the frequency markers are generated inside the POLYSKOP without cooperation of the test item, small residual voltages of the frequency-marker oscillators will reach the RF output. To produce the zero reference line, the range oscillators are keyed off during the flyback, but the marker oscillators continue to operate. Their signals pass from the output of the POLYSKOP through the test item on to the input of the SELEKTOMAT. During flyback, i.e. in the period in which the range oscillators are keyed off, also the SELEKTOMAT returns to its initial frequency position, reaching its highest sensitivity in logarithmic operation. Each input voltage greater than 10 µv will then force the SELEKTOMAT to tune automatically. In logarithmic operation, unwanted frequency-marker signals arriving with a level higher than about 50 mv may cause the SELEKTOMAT to tune to a spectrum line of the marker frequency. The probability for this to occur is greater in the lower than in the higher frequency ranges, since the energy of the marker-frequency oscillators decreases as the frequency becomes higher. The recommended remedy is to lower the input voltage of the SELEKTOMAT by connecting a 10- or 20-db pad in series with its input. If this remedy is undesirable for the measurement, it is necessary to switch the frequency-marker oscillator of the POLYSKOP out of circuit.

A similar trouble will occur if after the basic adjustment of the SELECTOMAT the calibration oscillator is not switched out of circuit.

3.2.3 Changing the Sweep Width or Centre Frequency of the POLYSKOP

Changing the sweep width or centre frequency of the POLYSKOP makes it necessary to readjust the starting frequency of the SELEKTOMAT in order to cover the full display width of the screen. This manipulation is inconvenient if the adjustment is frequently changed and can be avoided by automatic operation. In automatic operation, manual shifting of the starting frequency of the SELEKTOMAT is replaced by automatic shifting. The starting frequency is so controlled that it lies in the vicinity of the left-hand edge of the screen and is correspondingly shifted if sweep width and centre frequency of the POLYSKOP are changed. The START OF TRACKING control (12) serves to correct the position of the starting frequency in automatic operation. Automatic operation functions satisfactorily only under the following conditions:

a) The frequency range scanned by the POLYSKOP must be within the subrange of the SELEKTOMAT.

b) Within the range selected, the test item should have no attenuation peaks causing the tracking to be interrupted.

Automatic operation can be utilized only if these requirements are met and if tracking is possible from the left to the right edge of the display. For more particulars see section 5.6.3.

3.3 Swept-frequency Measurement with Heterodyning

If the swept-frequency signal is frequency-changed to an IF due to heterodyning in the test item (superheterodyne receiver), the sweep translated into the IF region may move in a direction opposite to that on the POLYSKOP. Suppose the POLYSKOP feeds a TV receiver with a signal swept in frequency from 200 to 220 Mc. The local oscillator operates at 250 Mc, the result being the IF changing from 50 to 30 Mc. However, the circuitry of the SELEKTOMAT is designed only for tracking a sweep going from low to high frequencies.

POLYSKOP II has on its rear been provided with a switch selecting the proper sweep direction. In the above case, this SWEEP DIRECTION selector of POLYSKOP II would have to be thrown to DOWNWARD to produce at the receiver IF output a sweep going from low to high frequencies. POLYSKOP I

has no such selector. However, section 7 gives simple instructions how to add such a selector to POLYSKOP I so as to permit measurements in the presence of heterodyning.

3.4 Interfering Fixed Frequencies in the Sweep Range

Non-shielded test items may pick up extraneous signals preventing the tracking action of the SELEKTOMAT from functioning satisfactorily. This is evidenced by intermittent interruptions in frequency tracking and possibly by permanent tuning of the SELEKTOMAT to the interfering frequency. Tuning and locking to an interfering signal is possible while the POLYSKOP sweep generator, which is on for 10 msec and off for another 10 msec for producing the zero reference line, is in its off condition.

Steps must also be taken to prevent the SELEKTOMAT from picking up unwanted signals from oscillators incorporated in the test item.

3.5 Use of Other Sweep Generators

The SELEKTOMAT will operate in conjunction with nearly any commercial sweep generator irrespective of whether its sweep drive is a sine, sawtooth, or triangular wave signal, etc. However, the frequency sweep of the generator should go upwards with time. A few sweep generators afford the means of disabling the key-off feature provided for producing the zero reference line during the flyback period of the oscilloscope. The SELEKTOMAT can readily be used also with the key-off feature switched off.

3.6 Use of Other Oscilloscopes

The SELEKTOMAT offers optimum accuracy and simplicity of operation in conjunction with the POLYSKOP, but other good oscilloscopes may also be used for display of the measured values. It is recommended that oscilloscopes with DC amplifiers for vertical deflection be employed since a stationary pattern independent of the amplitude is then obtainable. Reference line and measured value can be displayed at the same time as in the case of the POLYSKOP when using a dual-trace oscilloscope. But a satisfactory level measurement can be made also with a single-trace oscilloscope when the CALIBRATE button (5) is operated so as to display the measured value and reference line alternately.

3.7 Measuring Reflection Coefficients

The reflection coefficient of a 4-terminal or 2-terminal network can be measured with a directional coupler. A directional coupler of the coaxial type consists of a straight-through coaxial inner conductor with two loops placed apart from each other. The arrangement of the pick-up loops is such that the one picks up a voltage proportional to the incident, the other a voltage proportional to the reflected wave. Feeding a test item via such a directional coupler it is possible to make a comparison measurement of the incident and reflected voltages to obtain the

$$\text{reflection coefficient in } \% = \frac{\text{reflected voltage}}{\text{incident voltage}} \quad \text{or the}$$

$$\text{return loss} = \begin{array}{l}\text{level of incident voltage minus} \\ \text{level of reflected voltage.}\end{array}$$

To prevent the characteristic impedance of the coaxial centre conductor from being affected, the loops will pick up only a small portion of the measured voltage. When measuring reflection coefficients with a directional coupler it is therefore necessary to obtain a reliable reading of low RF signal levels. The SELEKTOMAT is excellent for this purpose both for point-by-point and swept-frequency measurements. The required test setup is shown in Fig. 8. The test item is fed with the maximum permissible RF voltage. In the case of passive test items where overdriving need not be feared, the full output voltage of the POLYSKOP, 0.5 v_{rms}, is applied to the test item. The output voltage applied to, say, a receiver should be reduced 20 to 30 db depending upon the permissible maximum. The SELEKTOMAT can then be used to measure the incident and reflected voltages, the ratio of which permits the reflection coefficient to be determined for any frequency.

The sensitivity obtainable with this test setup can be judged from the following examples: The directional coupler for the range 30 to 600 Mc of the Type ZUP has a coupling attenuation of about 30 db at 200 Mc. If a voltage of 0.5 v_{rms} is applied to the test item the reflected voltage with 100% mismatch termination is 30 db below 0.5 v, which is 15 mv. With a reflection coefficient of 1% a voltage of 15 mv : 100 = 150 µv is obtained. This voltage is largely sufficient for operation of the SELEKTOMAT. If only 50 mv is applied in order to prevent overdriving of the test item (e.g. a receiver input), a signal voltage of 15 µv is still obtained at the SELEKTOMAT if the reflection coefficient is 1%. The sensitivity of the measurement thus mainly depends on the quality of the directional coupler,

which is described in the data sheet of the Type ZUP. The logarithmic gain characteristic of the SELEKTOMAT ensures that even considerable variations in matching are reliably recognized.

3.8 Reflection-coefficient Measurement on Aerials

The SELEKTOMAT provides for particularly advantageous reflection-coefficient measurements on aerials. Note that aerials very easily pick up noise voltages which may be of the order of the signal voltage and disturb the operation of the SELEKTOMAT. If the aerial is directional, rotation may remedy this trouble.

The phase of the reflection coefficient cannot be determined with a test setup consisting of the SELEKTOMAT and the POLYSKOP. Impedance measurements with respect to magnitude and phase can be carried out with our Z-g diagraphs Types ZDU and ZDD.

.9 Point-by-point Measurement on Transmission Links

conventional signal generator is used at the transmitter location. Its requency is varied over the measurement range according to a scheme previously agreed upon. At the receiving end, the SELEKTOMAT indicates the requencies adjusted for at the transmitter location and measures the corresponding attenuation values. In automatic operation, the measured values eed only be read and recorded.

.10 Swept-frequency Measurement on Transmission Links

pply the output voltage of a POLYSKOP to the transmitter and use a SELEKTOAT at the receiving end. The SELEKTOMAT tracks the swept frequency of the OLYSKOP. The measured value may be indicated on a good oscilloscope, the ime base of the oscilloscope being synchronized by the square-wave signal erived from the REF. LINE output of the SELEKTOMAT. A second POLYSKOP can e used for indication at the receiving end provided both POLYSKOPs are fed rom the same power line. This condition is generally not fulfilled when he transmitter and receiver locations are distant from each other. Frequency determination at the receiving end is impossible without special arangements since the frequency markers generated in the POLYSKOP are not vailable. We recommend the use of an absorption-type frequency meter hich, connected to the SELEKTOMAT input, causes a dip in the displayed rve, serving as a frequency marker.

4. Specifications

Frequency range	30 to 400 Mc
in 7 bands	30 to 60 Mc 50 to 100 Mc 75 to 150 Mc 110 to 200 Mc 170 to 270 Mc 250 to 330 Mc 330 to 400 Mc
Input	R&S connector Dezifix B
Input impedance	50 Ω for BN 15221/50 60 Ω for BN 15221/60 75 Ω by matching pads; see "Recommended accessories" on page 21
VSWR	
with input attenuator setting 0 db	less than 2
with input attenuator setting -10 to -60 db	less than 1.15
Smallest indicated input voltage and threshold for frequency tracking	approx. 10 μV_{rms}
Max. input voltage	approx. 1 V_{rms}
Frequency response	flat within ±0.5 db over 10 Mc flat within ±1 db in selected band flat within 4 db over total range (30 to 400 Mc)
Input attenuator	0 to -60 db in 10-db steps
Accuracy	±0.5 db up to 250 Mc ±1 db above 250 Mc
RF input circuit	high-pass filter for frequencies above 20 Mc
Intermediate frequency	10.5 Mc
IF bandwidth	approx. ±150 kc for response down 3 db approx. ±1 Mc for response down 80 db
IF gain	linear or logarithmic, switch-selected

Tuning	manual or automatic, switch-selected
manual	coarse, continuous over selected band
	fine, continuous over approx. ±1 Mc
automatic	to strongest signal of selected band
Frequency tracking	over more than 100 Mc, but only in selected band; switch-selected
Maximum tracking speed	greater than 10 Mc/ms, tracking from low to high frequencies (in swept-frequency measurements)
Voltage indication	on panel meter or scope screen (POLYSKOP); switch-selected
linear	+1 to -20 db
accuracy	±3% of indicated value, but not better than ±0.1 db
logarithmic	0 to -80 db
accuracy	±2% of indicated value; but not better than ±0.5 db
Sensitivity	adjustable by approx. 3 db; calibration possible at 100 µv more than 10 db with POLYSKOP and linear indication
logarithmic indication	0 db = 100 mv -80 db = 10 µv } at 0 db setting of input attenuator
linear indication	0 db = 100 µv -20 db = 10 µv } at 0 db setting of input attenuator
Voltage calibration	by built-in calibration oscillator at approx. 35 Mc; calibration referred to sensitivity at 150 Mc; stability ±2%
IF outputs	for measured and reference-line voltages; adaptable 13-mm coaxial sockets 4/13 DIN 47284; see screw-in connectors page 21
Measured value	0-db indication: approx. -6 v across more than 100 kΩ
Reference line	0-db indication: approx. -6 v across more than 100 kΩ
Reference line	for measurements with POLYSKOP, continuously shiftable, adjustment with db calibration
Accuracy of relative level measurement	same as accuracy of panel-meter indication

requency indication	on panel meter
ccuracy	±2% of indicated frequency
ilot lamp	lights when no signal is received
canning frequency	approx. 1 cps for indication on POLYSKOP approx. 10 cps for indication on panel meter
tomatic gain control	increases continuously within 10 sec from minimum to maximum value; control by scanning process
wer supply	115/125/220/235 v, 47 to 63 cps; 135 va
lves, etc.	1 valve E 86 C 1 valve E 88 CC 1 valve EC 92 3 valves ECC 81 2 valves ECF 80 4 valves EF 93 3 valves EF 95 2 valves EL 95 2 valves EL 803 1 valve 6 BH 6 1 valve 6080 1 reference tube 85 A 2 1 reference tube 108 C 1 2 miniature glow lamps RL 210+RL210B 1 1-amp fuse 1 C DIN 41571 (for 220/235 v)
ensions (W x H x D)	540 x 234 x 378 mm R&S Standard Cabinet 56
ght	27 kg

Accessories

supplied with the set,
included in price . . . . . 1 power cord LK 333 (2 m)
2 patch cords with 13-mm plugs (60 cm)

Recommended accessories

to be ordered separately

(a) Matching Pad Type DAF, BN 18083 for impedance transformation 60 Ω to 75 Ω and vice versa.

(b) Reflectometer Type ZUP, BN 3569/50 for 50 Ω, BN 3569/60 for 60 Ω, BN 3569/75 for 75 Ω.

(c) Screw-in connectors

Order Number	Mating Connector
FMU 10990	R&S connector Dezifix B
FID 90990	Siemens 13-mm connector
FHD 10990	UHF connector (e.g. Amphenol)
FHD 20990	N connector (e.g. Amphenol)
FHD 30990	C connector (e.g. Amphenol)
FHD 40990	BNC connector (e.g. Amphenol)
FLA 20990	874 B (General Radio)

5. Circuit Description (see block diagram page 58 and circuit diagram page 65)

5.1 Input Attenuator

The signal passes from the input socket to the input attenuator, which is switchable in 10-db steps from 0 to 60 db. In contrast with other attenuators, this is a ladder attenuator without separating contacts; its sections are so proportioned that an accurate input impedance of 50 Ω or 60 Ω is obtained at any point. The output signal of the attenuator passes through an IF rejection filter (high-pass filter) to the mixer of the SELEKTOMAT.

5.2 Mixer

The mixer comprises three silicon diodes (G11-G12-G13); their circuit arrangement provides for low conversion loss and high permissible RF input voltage. Transformer section L2-C5 matches the mixer stage to the IF amplifier.

5.3 Local Oscillator

The mixer is fed from the local oscillator via capacitor C4. The local oscillator is switchable; it comprises 7 oscillator coils mounted on small ferrite-rod cores. The coil switched into circuit lies in the air gap of a ferrite magnet whose field strength is controlled by the anode current delivered by the control valves R813 and R814. In the unmagnetized condition the local oscillator operates at the lowest frequency of the band; with increasing field strength of the magnet the reception frequency increases up to the saturation point.

5.4 Amplifier

The input signal, converted in the mixer, is applied to the 5-stage IF amplifier R81 to R85. The input stage, R81, is a cascode circuit and provides for a noise figure of about 4 db. The following stages use variable-µ valves. Apart from the last stage, which feeds rectifier G14 via a resonant circuit, all stages are coupled by band-pass filters. The grid bias of the five IF amplifier valves is fixed when linear operation is selected. It can be changed by a small amount with potentiometer R126 to

ary the gain of the SELEKTOMAT. In logarithmic operation, all IF amplifier alves are controlled by the rectified voltage derived from rectifier G14. he IF amplifier valves, R82 to R85, draw the full control voltage while he cascode input stage R81 draws a portion of the control voltage which s adjusted by R16. The combination of four variable-mu IF valves with partly regulated cascode stage provides for an almost rigorously ogarithmic indication over a range of 80 db.

n logarithmic operation, also, the GAIN control R126 serves to calibrate or an absolute sensitivity. The rectified current of rectifier G14 is ndicated on meter I2 which is calibrated in db for lin. and log. operaions. The rectified voltage is also applied to the signal output where t is available for vertical deflection in the picture tube for swept-requency operation.

.5 Limiter and Control Circuit

he IF signal applied to rectifier G14 passes through C65 to the limiter 86, whose anode circuit comprises the control circuit producing the racking voltage. The control circuit is to tuned that the centre of the lope of its characteristic coincides with the centre of the IF pass-band. he pass-band characteristic of the IF amplifier and the resonance curve f the control circuit are shown in Fig. 10. The IF voltage across the ontrol circuit is rectified by diode G15 and amplified about 20 times by 87. It serves to drive the pulse section and to generate the tracking ontrol current in R814.

.6 Control of Tracking Action

ne tracking action is best understood when a given operating condition s considered. The SELEKTOMAT is connected, without test item, to the RF utput of the POLYSKOP. The POLYSKOP delivers an RF voltage which is aried within 10 msec from low towards high frequencies (see Fig. 11). or another 10 msec, the generator section of the POLYSKOP is disabled nd the signal voltage is generated again starting from low frequencies. nder the condition that the SELEKTOMAT tracks the swept frequency of the OLYSKOP, the voltage rectified at the output of the IF amplifier has the nape of a square wave (Fig. 12) of 50 cps repetition frequency. To achieve ne control of the local oscillator of the SELEKTOMAT, the signal must nange by a certain amount in the IF range during the tracking so that a

varying control voltage is obtained at the control circuit. The voltage rectified in the control circuit can be checked across point (1) after amplification in R87; the curve is shown in Fig. 13. Tracking starts with a voltage peak caused by the fact that the coil of the magnet core constitutes an inductive load impedance for R814. From then on the control voltage increases slowly, thus varying the current for the magnet coil; the current curve is shown in Fig. 14. At the moment where the signal generator section of the POLYSKOP is disabled, the voltage at the control circuit breaks down and the current through the magnet coil becomes zero. The local oscillator goes back to the lowest frequency adjusted for, where it remains until the process is repeated after the POLYSKOP signal generator is again switched into circuit. R814 is so adjusted by means of R123 that the noise components, which are superimposed on the control voltage when the POLYSKOP is switched off, cannot drive the valve. The variable negative feedback circuit R118 and C94 suppresses control oscillations in this control circuit. R813 operates in parallel to R814, which enables the local oscillator to be adjusted to any frequency within the band. By varying the grid bias of R813 with the COARSE and FINE frequency controls R113 and R114, the current sent through the magnet coil can be varied and any desired reception frequency can be obtained within the bands. It is obvious that the total current flowing through the magnet coil is the sum of the two valve currents (R813 and R814), so that frequency tracking via R814 can occur only from the frequency determined by R813 and take place towards higher frequencies only.

6.1 Frequency Indication

The total current flowing from R813 and R814 through the magnet coil is a direct measure of the reception frequency. This current is indicated on meter I1 which is calibrated in frequency for all bands. The voltage-dependent resistor R110 provides for linearity of the scale.

6.2 Pulse Section

The pulse section of the SELEKTOMAT comprises the valves R88 to R811; it has the following functions:

a) As long as the SELEKTOMAT does not receive a signal, the local oscillator is tuned over the entire reception range by a sawtooth generator operating at 1 cps.[*] At the moment a signal is received, the sawtooth generator is disabled.

[*] 1 cps in POLYSKOP operation or 10 cps in METER operation.

(b) In conjunction with this signal-seeking process the pulse section generates a control voltage varying the sensitivity of the SELEKTOMAT within 10 sec from minimum to maximum; the amplitude of the input signal is thus weighted. This amplitude control is disabled when a signal is received.

(c) A DC voltage is produced which can be applied to the POLYSKOP to give a variable calibrated reference line in swept-frequency operation for accurate measurement of attenuation values.

(d) A pilot lamp lights up when no signal is received.

(e) In swept-frequency operation with a POLYSKOP, the tracking range of the SELEKTOMAT is automatically controlled in such a way that always the full width of the screen is utilized even when the swept range is changed.

All the processes described above are triggered by the voltage taken from the control circuit; this voltage changes suddenly when the SELEKTOMAT receives a signal.

5.6.3 Signal-seeking Circuit

In automatic operation of the SELEKTOMAT, a sawtooth control current is applied to the magnet coil via R813 and thus the local oscillator is tuned once per second over the entire band. The sawtooth voltage required for driving R813 is generated in the sawtooth generator consisting of R89 and R810. R89 is a free-running blocking oscillator with a frequency of 1 cps.+) Capacitor C84 is charged to a high positive voltage within a few microseconds and discharged via R810 with constant current flow. R89 serves as recharging valve for capacitor C84. It influences the discharging current of R810 by a uniform opposite current in such a way that the potential across C84 remains nearly constant. This is necessary for automatic control of the starting frequency of the SELEKTOMAT in swept-frequency operation. In point-by-point measurements using a signal generator this recharging valve disables the sawtooth generator after reception has been established.

+) or 10 cps

.6.4 Automatic Gain Control

s long as no signal is received, the automatic gain control is effective part from the automatic signal-seeking circuit. It is controlled by a elay.

y this relay, capacitors C86 and C87, which are charged to -8 v, are con- ected to the control line for all IF amplifier valves and are slowly ischarged to zero. The discharging process takes about 10 seconds. During his time the gain of the IF amplifier becomes a minimum and slowly in- reases to the normal value while the automatic signal-seeking circuit unes the receiver ten times through the entire band. At each new scan- ing the sensitivity is increased by a certain amount; if several signals f different amplitude are applied to the SELEKTOMAT, the strongest one ill be received first. After reception has been achieved, the automatic ignal-seeking circuit and the automatic gain control are disabled. apacitors C86 and C87 are charged to -8 v from the power section via a ectifier arrangement.

.6.5 Pilot Lamp

ne relay that controls the automatic gain control also operates pilot amp R11. This lamp lights to indicate that no signal is received and hat the signal is being searched.

.6.6 Reference Line

n swept-frequency operation the panel meter for amplitude indication is ut of circuit. Instead, a calibrated variable reference line can be aken from the SELEKTOMAT and displayed, together with the measured value, n the POLYSKOP screen. Thus an amplitude measurement is possible with ne same accuracy as in a point-by-point measurement. The reference line epresents a voltage step of accurately-known level which occurs only uring the interval where the SELEKTOMAT is tracking.

.7 Calibration Oscillator

he calibration oscillator R816 and regulator valve R815 serve to cali-
rate the SELEKTOMAT for absolute sensitivity. R816 operates at 35 Mc and
s largely insensitive to fluctuations of the operating voltages and
emperature. An accurately-known portion of the oscillator voltage is
pplied to the mixer for gain adjustment.

.8 Stabilized Anode-supply Voltage

ll anode and screen-grid voltages are taken from the electronically
tabilized power section of conventional design, comprising the valves
817, R818, R819.

.9 Electronic Heater Regulation

ll receiver valves are fed with a stabilized AC voltage. The valves
820 to R822 together with transformer Tr2 form a regulating system de-
ivering a nearly sinusoidal heater voltage of high power and high
tability. This ensures that even with AC supply fluctuations between
00 and 240 v all valves that are important for the performance of the
et are fed with a constant heater voltage.

. Maintenance and Repair

.1 Level Values

ne IF and RF levels of the stages are shown in Fig. 15.

.2 Replacement of the Mixer Diodes

ne mixer diodes G11, G12, and G13 are accessible after removal of the ase panel and can be withdrawn from their sockets. The replacement items ust be of the type specified in the table of replaceable parts. Replace- ent of the mixer diodes is necessary when the overall sensitivity of ne set has dropped although the IF amplifier has its normal gain.

.3 Replacement of Valves

nen replacing valves, note the following remarks:

.3.1 Oscillator R812

nis valve (E 86 C) should have a transconductance greater than 15 ma/v o ensure that the oscillator operates satisfactorily also in the range 30 to 400 Mc.

.3.2 IF Amplifier R81 to R85

eplacement of these valves may require the calibration of the logarith- ic characteristic (see 6.4). Detuning of the IF pass-band characteristic s not likely.

3.3 Limiter R86

e recommend that only an American valve (of the Type 6 BN 6) be used.

3.4 R87 and R88

eplacement of R87 and R88 may require calibration of the pulse section nd of the bias for R813 (see 6.7).

.4 Calibration of the Logarithmic Characteristic

he logarithmic characteristic depends on the total portion of regulating oltage used for the cascode input stage R81 and the IF stages R82 to 85. The required regulating voltage can be adjusted with potentiometers 16 and R62. After replacement of R81 to R85, new calibration is necesary to reobtain the given logarithmic characteristic. Proceed as follows: eed a signal of 100 µv and 150 Mc from a good signal generator to the ELEKTOMAT. Switch to LIN. INDICATION and fully advance the GAIN control or checking the overall gain in the tuned condition. The meter should ndicate full deflection (+1 db). The gain can be corrected with trimmer 18 (see 6.5). Turn the GAIN control back so far that the meter indicates db. After switching to LOG. INDICATION calibrate the logarithmic range. pply a 100-µv signal (-60 db) and a 10-mv signal (-20 db) alternately o the input. Adjust with potentiometer R62 to the scale mark -60 db and ith potentiometer R16 to the scale mark -20 db. Since these adjustments re interdependent they should be repeated several times.

he series resistor R69 of the meter is factory-adjusted to a fixed value nd must not be varied in any case.

.5 IF Pass-band Characteristic

he band-pass filters between R81 and R82, R82 and R83, R83 and R84 are oupled critically, while that between R84 and R85 is coupled somewhat vercritically in order to obtain a flat pass-band characteristic with he single tuned circuit following R85. The transformer circuit L2-C5 beween the mixer and R81 does not substantially affect the pass-band charcteristic; it is only adjusted for maximum gain. The gain of the IF mplifier is variable with the front-panel control R126 and inside the et with trimmer C18 at the grid of R82; it can be so adjusted that in inear operation with 100 µv input and the GAIN control fully advanced, he meter reads full deflection (+1 db). The overall characteristic of he IF amplifier in linear operation is shown in Fig. 16. It should be lat over at least 250 kc at both sides of the centre frequency of 10.5 Mc. hould a slight sag occur as a result of a valve replacement, C59 proded in the single tuned circuit following R85 permits a correction to made.

.6 Control Circuit

he tuning of the control circuit following R86 is of decisive importance or satisfactory tracking. The required pass-band characteristic can be een from Fig. 16.

.7 Pulse Section

Recalibration after failure to track

or adjustment of the various potentials in the pulse section refer to ig. 17. The adjustment can be made without a change in the set, using the est sockets (1) to (7). Use a good oscilloscope with DC amplifier and h input impedance greater than 1 MΩ.

onnect the SELEKTOMAT to a POLYSKOP in the same arrangement as described nder 3.2.1. The most important adjustment is that of potentiometer R123 or the operating point of R814. Since the control voltage applied to ne control grid of R814 has a relatively strong noise component, the perating point should be chosen so that the noise peaks still lie in ne stop band of R814. If R87 or R814 is replaced, readjustment of the otentiometer may become necessary. Set the GAIN control for full gain nd switch to logarithmic operation. Turn potentiometer R123 clockwise far that the curve shown in Fig. 17 is obtained at check point (1). nsufficient negative bias of R814 (potentiometer R123 turned too far lockwise) results in noise peaks projecting into the range of modulation the valve and disturbing the tracking. Too high a negative bias potentiometer R123 turned too far counterclockwise) causes the tracking fail at low input voltages. The voltage difference between the noise evel and the start of tracking should be about 10 v. Potentiometer R118, or the adjustment of negative feedback, need generally not be varied fter replacement of valves. If readjustment should be necessary, carry out at great sweep width and adjust the negative feedback so that the urve does not show dips at check point (1). When the potentiometer is urned fully counterclockwise, a high-frequency oscillation is superim- osed upon the curve; this oscillation disappears when the potentiometer turned clockwise. The negative feedback should be increased only so ar that the curve is completely free from high-frequency oscillations. urther increase of the feedback impairs the tracking properties, par- icularly at great sweep width.

If the operating point of R814 has been adjusted (with R123), a readjustment of potentiometer R75 (operating point of R88I) may also be necessary. Misadjustment of this potentiometer causes faulty operation of the relay and of the pilot lamp.

5.8 Calibration Oscillator

Checking and readjustment of the voltage fed from the calibration oscillator to the mixer is made using a good signal generator which delivers an accurate output voltage 100 µv for comparison. The coupling loop L12 can be externally adjusted until the same meter deflection is obtained with the external reference voltage applied and with operation of the calibration oscillator (see section 2.2).

5.9 Power Supply

The regulated heater voltage can be adjusted with control R161, while the voltage is measured across check point (8) with a good AC voltmeter (preferably Multavi 5). The anode supply voltage should be 180 v; it can be corrected with R145. It is measured across capacitors C116 and C117.

5.10 Reference Lines

After replacement of the Zener diode G18 the reference-line potential can be corrected with R97. Proceed as follows:
Measure the voltage across the signal output with a valve voltmeter, while the SELEKTOMAT is not tuned. This voltage is between 0 and -1.5 v, dependent on the setting of the GAIN control R126. Feed the SELEKTOMAT from a signal generator and tune in the usual way. Adjust the signal-generator output so that the meter of the SELEKTOMAT indicates 0 db. The voltage at the signal output is then about -6 v. Determine and record the difference of the voltages measured with and without signal. Measure the voltage across the reference-line output with the reference-line potentiometer in its 0-db position. Adjust R25 so that with and without signal applied to the input of the SELEKTOMAT the same voltage difference is obtained as at the signal output. This measurement is necessary because both output voltages have DC components which are not displayed on the screen in swept-frequency measurements.

. Modifying Earlier POLYSKOP Models for Switch-selected Sweep Direction

arlier POLYSKOP models do not comprise a switchover facility for upward r downward sweep direction, which is necessary for swept-frequency easurements on test items in which a conversion takes place (see section .3). According to the diagrams of Fig. 18, such a switchover facility an be added to earlier models. The leads to the switch are uncritical. he switch may be mounted at any point.

. References

. . . . . H. Lucius,
"Der SELEKTOMAT - ein Fortschritt in der Meßgeräteautomation"
Elektronik, Heft 7, 1960

. . . . . H. Lucius,
"Das POLYSKOP, ein Breitbandwobbler von 0,5...400 MHz"
R&S-Mitteilungen, Heft 10, 1958

Table of Replaceable Parts

Ref. No.	Designation	Ratings	R&S Stock No.
2	Capacitor, coupling		incl. in 15221
3	Capacitor, ceramic	22 pf	CCG 68/22
4	Capacitor, ceramic	2 pf	CCG 11/2
5	Capacitor, ceramic	12 pf	CCH 31/12
6	Capacitor, ceramic	2200 pf	CCG 94/2200
7	Capacitor, feed-through	500 pf/500 v	CFR 1/500/500
8	Capacitor, ceramic	2200 pf	CCG 94/2200
9	Capacitor, ceramic	2200 pf	CCG 94/2200
10	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
11	Trimmer, air	2 to 11 pf	CV 61 509
12	Capacitor, ceramic	27 pf	CCH 31/27
13	Capacitor, ceramic	27 pf	CCH 31/27
14	Trimmer, air	2 to 11 pf	CV 61 509
15	Capacitor, ceramic	6 pf	CCG 68/6
16	Capacitor, ceramic	470 pf	CCG 94/470
17	Capacitor, feed-through	500 pf/500 v	CFR 1/500/500
18	Trimmer, air		CV 8025
19	Capacitor, ceramic	2200 pf	CCG 94/2200
20	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
21	Capacitor, mica	700 pf ±1%/250 v	CGU 700/1/250/1
22	Capacitor, mica	117 pf ±1%/250 v	CGU 117/1/250/0
23	Capacitor, mica	54 pf ±2%/250 v	CGU 54/2/250/0
24	Capacitor, mica	101 pf ±1%/250 v	CGU 101/1/250/0
25	Capacitor, ceramic	2200 pf	CCG 94/2200
26	Trimmer, air	2 to 11 pf	CV 61 509
27	Capacitor, ceramic	27 pf	CCH 31/27

ef. o.	Designation	Ratings	R&S Stock No.
28	Capacitor, ceramic	27 pf	CCH 31/27
29	Trimmer, air	2 to 11 pf	CV 61 509
30	Capacitor, feed-through	500 pf/500 v	CFR 1/500/500
31	Capacitor, ceramic	470 pf	CCG 94/470
32	Capacitor, ceramic	2200 pf	CCG 94/2200
33	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
34	Capacitor, ceramic	2200 pf	CCG 94/2200
35	Trimmer, air	2 to 11 pf	CV 61 509
36	Capacitor, ceramic	27 pf	CCH 31/27
37	Capacitor, ceramic	27 pf	CCH 31/27
38	Trimmer, air	2 to 11 pf	CV 61 509
40	Capacitor, ceramic	470 pf	CCG 94/470
45	Capacitor, feed-through	500 pf/500 v	CFR 1/500/500
47	Capacitor, ceramic	2200 pf	CCG 94/2200
48	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
49	Capacitor, ceramic	2200 pf	CCG 94/2200
50	Trimmer, air	2 to 11 pf	CV 61 509
51	Capacitor, ceramic	27 pf	CCH 31/27
52	Capacitor, ceramic	27 pf	CCH 31/27
53	Trimmer, air	2 to 11 pf	CV 61 509
54	Capacitor, feed-through	500 pf/500 v	CFR 1/500/500
55	Capacitor, ceramic	470 pf	CCG 94/470
56	Capacitor, ceramic	2200 pf	CCG 94/2200
57	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
58	Capacitor, ceramic	2200 pf	CCG 94/2200
59	Trimmer, air	2 to 11 pf	CV 61 509
60	Capacitor, ceramic	approx. 8 pf	CCH 11/8

f.	Designation	Ratings	R&S Stock No.
4	Capacitor, ceramic	10 pf	CCG 68/10
5	Trimmer, air	2 to 11 pf	CV 61 509
6	Capacitor, ceramic	100 pf	CCH 68/100
7	Capacitor, feed-through	500 pf/500 v	CFR 1/500/500
8	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
9	Capacitor, ceramic	2200 pf	CCG 94/2200
5	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
6	Capacitor, ceramic	2200 pf	CCG 94/2200
7	Trimmer, air	2 to 11 pf	CV 61 509
8	Capacitor, ceramic	33 pf	CCH 31/33
9	Capacitor, ceramic	33 pf	CCH 31/33
0	Trimmer, air	2 to 11 pf	CV 61 509
1	Capacitor, ceramic	150 pf	CCH 68/150
2	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
3	Capacitor, paper	10,000 pf/250 v	CPK 10 000/250
4	Capacitor, paper	100,000 pf/250 v	CPK 100 000/250
5	Capacitor, paper	5000 pf/630 v	CPK 5000/630
6	Capacitor, electrolytic	100 µf/35 v	CED 21/100/35
7	Capacitor, electrolytic	100 µf/35 v	CED 21/100/35
8	Capacitor, ceramic	2200 pf	CCG 94/2200
9	Capacitor, paper	50,000 pf/630 v	CPK 50 000/630
0	Capacitor, ceramic	8 pf	CCG 41/8
1	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
2	Capacitor, lacquer-type	0.5 µf/60 v	CKL 2/0,5/60
3	Capacitor, electrolytic	32 µf/350 v	CEG 21/32+32/350 2nd capacitor is C115
4	Capacitor, ceramic	220 pf	CCH 68/220
5	Capacitor, ceramic	56 pf	CCH 68/56

Ref. No.	Designation	Ratings	R&S Stock No.
C96	Capacitor, ceramic	270 pf	CCH 68/270
C97	Capacitor, ceramic	1 pf	CCC 11/1
C98	Capacitor, ceramic	5 pf	CCG 11/5
C100	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
C101	Capacitor, ceramic	330 pf	CCG 94/330
C102	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
C103	Capacitor, ceramic	10 pf	CCG 68/10
C105	Capacitor, ceramic	6 pf	CCG 68/6
C106	Capacitor, ceramic	10 pf	CCH 11/10
C107	Capacitor, ceramic	10 pf	CCH 11/10
C108	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
C109	Capacitor, ceramic	1000 pf	CCG 94/1000
C113	Capacitor, paper	50,000 pf/250 v	CPK 50 000/250
C114	Capacitor, paper	10,000 pf/250 v	CPK 10 000/250
C115	Capacitor, electrolytic	32 µf/350 v	CEG 21/32+32/350
C116	Capacitor, electrolytic	100 µf/350 v	CEG 21/100+100/350
C117	Capacitor, electrolytic	100 µf/350 v	CEG 21/100+100/350
C120	Capacitor, lacquer-type	0.25 µf/60 v	CKL 2/0,25/60
C121	Capacitor, lacquer-type	0.25 µf/60 v	CKL 2/0,25/60
C122	Capacitor, lacquer-type	0.25 µf/60 v	CKL 2/0,25/60
C123	Capacitor, paper	5000 pf/630 v	CPK 5000/630
C124	Capacitor, lacquer-type	0.25 µf/60 v	CKL 2/0,25/60
C125	Capacitor, electrolytic	100 µf/350 v	CEG 21/100+100/350
C126	Capacitor, electrolytic	100 µf/350 v	CEG 21/100+100/350
C127	Capacitor, MP	0.5 µf/250 v	CMR 0,5/250/2
C128	Capacitor, electrolytic	8 µf/350 v	CED 21/8/350
C129	Capacitor, synth. foil	2500 pf/250 v	CKS 2500/250
C130	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500

ef. o.	Designation	Ratings	R&S Stock No.
131	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
132	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
133	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
134	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
135	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
136	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
137	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
138	Capacitor, feed-through	5000 pf/500 v	CFR 1/5000/500
11	Diode, silicon		GK/1011 C
12	Diode, silicon		GK/1011 C
13	Diode, silicon		GK/1011 C
14	Diode, germanium		GK/GD 8 E
15	Diode, germanium		GK/GD 8 E
16	Diode, silicon		GK/OA 202
17	Diode, germanium		GK/GD 8 E
18	Diode, Zener		GK/Z 8
19	Rectifier, silicon		GK/0307
111	Diode, germanium		GK/GD 8 E
112	Diode, germanium		GK/GD 8 E
113	Rectifier, selenium		GNB 14/150/30
114	Rectifier, selenium		GNB 14/150/30
115	Rectifier, silicon		GK/0307
116	Rectifier, silicon		GK/0307
117	Rectifier, silicon		GK/0307
118	Rectifier, silicon		GK/0307
119	Rectifier, silicon		GK/0307

Ref. No.	Designation	Ratings	R&S Stock No.
M1	Ammeter, moving-coil		INS 30 505 with scale according to 15221-51
M2	Ammeter, moving-coil		INS 30 203 with scale according to 15221-50
W1	Cable		15221-49
W2	Cable, RF	50 Ω	15221-16/50 for BN 15221/50
		60 Ω	15221-16/60 for BN 15221/60
W3	Power cord		LK 333
W4	Patch cord		R 6455/62
W5	Patch cord		R 6455/62
W6	Cable, RF		LKK 92220
W8	Cable, RF		LKK 92220
W9	Cable, RF		LKK 92220
W10	Cable, RF		LKK 92220
W11	Cable, RF		LKK 92220
W12	Cable, RF		LKK 92220
L2	Coil, IF		15221-52
L3	Coil, IF		15221-18.4
L4	Coil, IF		15221-18.4
L5	Coil, IF		15221-18.4
L6	Coil, IF		15221-18.4
L7	Coil, IF		15221-18.4
L8	Coil, IF		15221-18.4
L9	Coil, IF		15221-18.4
L10	Coil, IF		15221-18.4
L11	Coil, IF		15221-22.1
L12	Coil, coupling		15221-62.2
L13	Coil, IF		15221-18.4
L14	Coil, IF		15221-18.4

f. .	Designation	Ratings	R&S Stock No.
5	Coil, oscillator		15221-62.1
6	Coil		15221-54
7	Coil, oscillator		15221-28.3
8	Coil, oscillator		15221-28.4
9	Coil, oscillator		15221-28.5
0	Coil, oscillator		15221-28.6
1	Coil, oscillator		15221-28.7
2	Coil, oscillator		15221-28.8
3	Coil, oscillator		15221-28.9
4	Choke, RF		DUF 311/20
5	Choke, RF		DUF 311/20
6	Choke, RF		DUF 311/20
7	Choke, RF		DUF 311/20
8	Choke, RF		DUF 311/20
9	Choke, RF		DUF 111/30
0	Choke, RF		DUF 311/20
1	Choke, RF		DUF 311/20
2	Choke, RF		DUF 311/20
3	Choke, RF		DUF 111/30
4	Choke, RF		DUF 311/20
5	Choke, RF		DUF 311/20
7	Choke, RF		DUF 311/20
8	Choke, RF		DUF 311/20
9	Choke, RF		DUF 311/20
0	Choke, RF		DUF 311/20
1	Choke, RF		DUF 311/20
2	Choke, RF		DUF 311/20

ef. o.	Designation	Ratings	R&S Stock No.
43	Choke, RF		DUF 311/20
44	Choke, RF		DUF 311/20
45	Choke, RF		DUF 311/20
46	Coil	0.328 µh	15221-48.5
47	Coil	0.285 µh	15221-48.5
48	Choke (gr.)		15221-66
49	Choke (gr.)		15221-67
o1	Blower		ZV 220/10
1	Resistor, depos. carbon	142.2 Ω ±1%/0.05 w	WFS 20/142,2/1/0,05 for BN 15221/50
		170.6 Ω ±1%/0.05 w	WFS 20/170,6/1/0,05 for BN 15221/60
2	Resistor, depos. carbon	95.8 Ω ±1%/0.05 w	WFS 20/95,8/1/0,05 for BN 15221/50
		115 Ω ±1%/0.05 w	WFS 20/115/1/0,05 for BN 15221/60
3	Resistor, depos. carbon	142.2 Ω ±1%/0.05 w	WFS 20/142,2/1/0,05 for BN 15221/50
		170.6 Ω ±1%/0.05 w	WFS 20/170,6/1/0,05 for BN 15221/60
4	Resistor, depos. carbon	95.8 Ω ±1%/0.05 w	WFS 20/95,8/1/0,05 for BN 15221/50
		115 Ω ±1%/0.05 w	WFS 20/115/1/0,05 for BN 15221/60
5	Resistor, depos. carbon	142.2 Ω ±1%/0.05 w	WFS 20/142,2/1/0,05 for BN 15221/50
		170.6 Ω ±1%/0.05 w	WFS 20/170,6/1/0,05 for BN 15221/60
6	Resistor, depos. carbon	95.8 Ω ±1%/0.05 w	WFS 20/95,8/1/0,05 for BN 15221/50
		115 Ω ±1%/0.05 w	WFS 20/115/1/0,05 for BN 15221/60

ef. o.	Designation	Ratings	R&S Stock No.
7	Resistor, depos. carbon	142.2 Ω ±1%/0.05 w	WFS 20/142,2/1/0,05 for BN 15221/50
		170.6 Ω ±1%/0.05 w	WFS 20/170,6/1/0,05 for BN 15221/60
8	Resistor, depos. carbon	95.8 Ω ±1%/0.05 w	WFS 20/95,8/1/0,05 for BN 15221/50
		115 Ω ±1%/0.05 w	WFS 20/115/1/0,05 for BN 15221/60
9	Resistor, depos. carbon	142.2 Ω ±1%/0.05 w	WFS 20/142,2/1/0,05 for BN 15221/50
		170.6 Ω ±1%/0.05 w	WFS 20/170,6/1/0,05 for BN 15221/60
10	Resistor, depos. carbon	95.8 Ω ±1%/0.05 w	WFS 20/95.8/1/0.05 for BN 15221/50
		115 Ω ±1%/0.05 w	WFS 20/115/1/0,05 for BN 15221/60
11	Resistor, depos. carbon	142.2 Ω ±1%/0.05 w	WFS 20/142,2/1/0,05 for BN 15221/50
		170.6 Ω ±1%/0.05 w	WFS 20/170,6/1/0,05 for BN 15221/60
12	Resistor, depos. carbon	65.8 Ω ±1%/0.05 w	WFS 20/65,8/1/0,05 for BN 15221/50
		78.9 Ω ±1%/0.05 w	WFS 20/78,9/1/0,05 for BN 15221/60
13	Resistor, depos. carbon	60 Ω/0.1 w	WF 60/0,1
14	Resistor, depos. carbon	50 kΩ/0.25 w	WF 50 k/0,25
15	Resistor, depos. carbon	200 Ω/0.25 w	WF 200/0,25
16	Resistor, depos. carbon, variable	50 kΩ lin.	WS 9122 F/50 k
17	Resistor, depos. carbon	100 Ω/0.1 w	WF 100/0,1
18	Resistor, depos. carbon	80 Ω/0.1 w	WF 80/0,1
25	Resistor, depos. carbon	50 kΩ/0.25 w	WF 50 k/0,25
26	Resistor, depos. carbon	12.5 kΩ/0.1 w	WF 12,5 k/0,1
27	Resistor, depos. carbon	50 kΩ/0.25 w	WF 50 k/0,25
28	Resistor, depos. carbon	2 kΩ/0.25 w	WF 2 k/0,25

Ref. No.	Designation	Ratings	R&S Stock No.
R7	Resistor, depos. carbon	142.2 Ω ±1%/0.05 w	WFS 20/142,2/1/0,05 for BN 15221/50
		170.6 Ω ±1%/0.05 w	WFS 20/170,6/1/0,05 for BN 15221/60
R8	Resistor, depos. carbon	95.8 Ω ±1%/0.05 w	WFS 20/95,8/1/0,05 for BN 15221/50
		115 Ω ±1%/0.05 w	WFS 20/115/1/0,05 for BN 15221/60
R9	Resistor, depos. carbon	142.2 Ω ±1%/0.05 w	WFS 20/142,2/1/0,05 for BN 15221/50
		170.6 Ω ±1%/0.05 w	WFS 20/170,6/1/0,05 for BN 15221/60
R10	Resistor, depos. carbon	95.8 Ω ±1%/0.05 w	WFS 20/95.8/1/0.05 for BN 15221/50
		115 Ω ±1%/0.05 w	WFS 20/115/1/0,05 for BN 15221/60
R11	Resistor, depos. carbon	142.2 Ω ±1%/0.05 w	WFS 20/142,2/1/0,05 for BN 15221/50
		170.6 Ω ±1%/0.05 w	WFS 20/170,6/1/0,05 for BN 15221/60
R12	Resistor, depos. carbon	65.8 Ω ±1%/0.05 w	WFS 20/65,8/1/0,05 for BN 15221/50
		78.9 Ω ±1%/0.05 w	WFS 20/78,9/1/0,05 for BN 15221/60
R13	Resistor, depos. carbon	60 Ω/0.1 w	WF 60/0,1
R14	Resistor, depos. carbon	50 kΩ/0.25 w	WF 50 k/0,25
R15	Resistor, depos. carbon	200 Ω/0.25 w	WF 200/0,25
R16	Resistor, depos. carbon, variable	50 kΩ lin.	WS 9122 F/50 k
R17	Resistor, depos. carbon	100 Ω/0.1 w	WF 100/0,1
R18	Resistor, depos. carbon	80 Ω/0.1 w	WF 80/0,1
R25	Resistor, depos. carbon	50 kΩ/0.25 w	WF 50 k/0,25
R26	Resistor, depos. carbon	12.5 kΩ/0.1 w	WF 12,5 k/0,1
R27	Resistor, depos. carbon	50 kΩ/0.25 w	WF 50 k/0,25
R28	Resistor, depos. carbon	2 kΩ/0.25 w	WF 2 k/0,25

Ref. No.	Designation	Ratings	R&S Stock No.
R29	Resistor, depos. carbon	12.5 kΩ/0.1 w	WF 12,5 k/0,1
R30	Resistor, depos. carbon	5 kΩ/0.25 w	WF 5 k/0,25
R31	Resistor, depos. carbon	80 Ω/0.25 w	WF 80/0,25
R32	Resistor, depos. carbon	30 kΩ/0.25 w	WF 30 k/0,25
R34	Resistor, depos. carbon	12.5 kΩ/0.1 w	WF 12,5 k/0,1
R35	Resistor, depos. carbon	25 kΩ/0.25 w	WF 25 k/0,25
R36	Resistor, depos. carbon	2 kΩ/0.25 w	WF 2 k/0,25
R37	Resistor, depos. carbon	5 kΩ/0.25 w	WF 5 k/0,25
R38	Resistor, depos. carbon	12.5 kΩ/0.1 w	WF 12,5 k/0,1
R39	Resistor, depos. carbon	80 Ω/0.25 w	WF 80/0,25
R40	Resistor, depos. carbon	12.5 kΩ/0.1 w	WF 12,5/0,1
R41	Resistor, depos. carbon	25 kΩ/0.25 w	WF 25 k/0,25
R42	Resistor, depos. carbon	2 kΩ/0.25 w	WF 2 k/0,25
R43	Resistor, depos. carbon	12.5 kΩ/0.1 w	WF 12,5 k/0,1
R45	Resistor, depos. carbon	5 kΩ/0.25 w	WF 5 k/0,25
R50	Resistor, depos. carbon	80 Ω/0.25 w	WF 80/0,25
R51	Resistor, depos. carbon	20 kΩ/0.1 w	WF 20 k/0,1
R52	Resistor, depos. carbon	25 kΩ/0.25 w	WF 25 k/0,25
R53	Resistor, depos. carbon	2 kΩ/0.25 w	WF 2 k/0,25
R54	Resistor, depos. carbon	5 kΩ/0.25 w	WF 5 k/0,25
R55	Resistor, depos. carbon	20 kΩ/0.1 w	WF 20 k/0,1
R56	Resistor, depos. carbon	80 Ω/0.25 w	WF 80/0,25
R59	Resistor, depos. carbon	12.5 kΩ/0.1 w	WF 12,5 k/0,1
R60	Resistor, depos. carbon	25 kΩ/0.25 w	WF 25 k/0,25
R61	Resistor, depos. carbon	2 kΩ/0.25 w	WF 2 k/0,25
R62	Resistor, depos. carbon, variable	10 kΩ lin.	WS 9122 F/10 k
R63	Resistor, depos. carbon	50 kΩ/0.25 w	WF 50 k/0,25

Ref. No.	Designation	Ratings	R&S Stock No.
R64	Resistor, depos. carbon	80 kΩ/0.25 w	WF 80 k/0,25
R65	Resistor, depos. carbon	100 kΩ/0.25 w	WF 100 k/0,25
R66	Resistor, depos. carbon	2 kΩ/0.25 w	WF 2 k/0,25
R67	Resistor, depos. carbon	12.5 kΩ/0.1 w	WF 12,5 k/0,1
R68	Resistor, depos. carbon	100 k/0.25 w	WF 100 k/0,25
R69	Resistor, depos. carbon, variable	100 kΩ lin.	WS 9122 F/100 k
R70	Resistor, depos. carbon	50 kΩ/0.25 w	WF 50 k/0,25
R71	Resistor, depos. carbon	125 kΩ/0.25 w	WF 125 k/0,25
R72	Resistor, depos. carbon	125 kΩ/0.25 w	WF 125 k/0,25
R73	Resistor, depos. carbon	25 kΩ/0.25 w	WF 25 k/0,25
R74	Resistor, depos. carbon	160 kΩ/0.25 w	WF 160 k/0,25
R75	Resistor, depos. carbon, variable	1 MΩ lin.	WS 9122 F/1 M
R76	Resistor, depos. carbon	200 kΩ/0.25 w	WF 200 k/0,25
R77	Resistor, depos. carbon	1 MΩ/0.25 w	WF 1 M/0,25
R78	Resistor, depos. carbon	200 kΩ/0.25 w	WF 200 k/0,25
R79	Resistor, depos. carbon	100 kΩ/0.25 w	WF 100 k/0,25
R81	Resistor, depos. carbon, variable	1 MΩ lin.	WS 9122 F/1 M
R82	Resistor, depos. carbon	1 kΩ/0.25 w	WF 1 k/0,25
R83	Resistor, depos. carbon	1 MΩ/0.25 w	WF 1 M/0,25
R84	Resistor, depos. carbon	1.6 MΩ/0.25 w	WF 1,6 M/0,25
R85	Resistor, depos. carbon	1 MΩ/0.25 w	WF 1 M/0,25
R86	Resistor, depos. carbon, variable	250 kΩ lin.	WS 9126/250 k
R87	Resistor, depos. carbon	250 kΩ/0.25 w	WF 250 k/0,25
R88	Resistor, depos. carbon	20 kΩ/0.25 w	WF 20 k/0,25
R89	Resistor, depos. carbon	50 kΩ/0.25 w	WF 50 k/0,25

Ref. No.	Designation	Ratings	R&S Stock No.
R90	Resistor, depos. carbon	8 kΩ/0.25 w	WF 8 k/0,25
R91	Resistor, depos. carbon, variable	500 kΩ lin.	WS 9122 F/500 k
R92	Resistor, depos. carbon	5 MΩ/0.25 w	WF 5 M/0,25
R93	Resistor, depos. carbon	500 kΩ/0.25 w	WF 500 k/0,25
R94	Resistor, depos. carbon	200 kΩ/0.25 w	WF 200 k/0,25
R95	Resistor, depos. carbon	40 kΩ/0.5 w	WF 40 k/0,5
R96	Resistor, depos. carbon	100 kΩ/0.25 w	WF 100 k/0,25
R97	Resistor, depos. carbon, variable	25 kΩ lin.	WS 9122 F/25 k
R98	Resistor, depos. carbon, variable	20 kΩ	15221-61
R99	Resistor, depos. carbon	10 Ω/0.25 w	WF 10/0,25
R100	Resistor, depos. carbon	100 Ω/0.25 w	WF 100/0,25
R101	Resistor, depos. carbon	60 kΩ/0.25 w	WF 60 k/0,25
R103	Resistor, depos. carbon	250 kΩ/0.5 w	WFO 250 k/0,5
R102	Resistor, depos. carbon	10 kΩ/0.25 w	WF 10 k/0,25
R104	Resistor, depos. carbon	2 MΩ/0.25 w	WF 2 M/0,25
R106	Resistor, depos. carbon	30 kΩ/0.1 w	WF 30 k/0,1
R107	Resistor, depos. carbon	approx. 2.5 kΩ/0.5 w	WFO 2,5 k/0,5
R109	Resistor, depos. carbon	1.6 kΩ/1 w	WF 1,6 k/1
R110	Varistor		WUC 41031
R111	Resistor, depos. carbon	approx. 20 kΩ/0.25 w	WF 20 k/0,25
R112	Resistor, depos. carbon	5 kΩ/0.25 w	WF 5 k/0,25
R113	Resistor, depos. carbon, variable	50 kΩ lin.	WS 7126/50 k
R114	Resistor, depos. carbon, variable	2.5 kΩ lin.	WS 7126/2,5 k
R115	Resistor, depos. carbon	500 kΩ/0.25 w	WF 500 k/0,25
R116	Resistor, depos. carbon	1 kΩ/0.1 w	WF 1 k/0,1
R117	Resistor, depos. carbon	200 Ω/1 w	WF 200/1

Ref. No.	Designation	Ratings	R&S Stock No.
R118	Resistor, depos. carbon, variable	500 kΩ lin.	WS 9122 F/500 k
R119	Resistor, depos. carbon	5 kΩ/0.25 w	WF 5 k/0,25
R120	Resistor, depos. carbon, variable	5 kΩ lin.	WS 9122 F/5 k
R122	Resistor, depos. carbon	100 kΩ/0.25 w	WF 100 k/0,25
R123	Resistor, depos. carbon, variable	100 kΩ lin.	WS 9122 F/100 k
R124	Resistor, depos. carbon	250 kΩ/0.25 w	WF 250 k/0,25
R125	Resistor, depos. carbon	100 kΩ/0.25 w	WF 100 k/0,25
R126	Resistor, depos. carbon, variable	500 Ω lin.	WS 9126/500
R127	Resistor, depos. carbon	2.5 kΩ/0.25 w	WF 2,5 k/0,25
R128	Resistor, depos. carbon	80 kΩ/0.25 w	WF 80 k/0,25
R129	Resistor, depos. carbon, variable	25 kΩ lin.	WS 9122 F/25 k
R130	Resistor, depos. carbon	5 kΩ/0.25 w	WF 5 k/0,25
R131	Resistor, depos. carbon	50 kΩ/0.5 w	WF 50 k/0,5
R134	Resistor, depos. carbon	500 kΩ/0.25 w	WF 500 k/0,25
R135	Resistor, depos. carbon	1 kΩ/0.25 w	WF 1 k/0,25
R136	Resistor, depos. carbon	40 kΩ/0.1 w	WF 40 k/0,1
R137	Resistor, depos. carbon	1 kΩ/0.1 w	WF 1 k/0,1
R138	Resistor, depos. carbon	1 kΩ/0.25 w	WF 1 k/0,25
R139	Resistor, depos. carbon	2.5 kΩ/0.25 w	WF 2,5 k/0,25
R140	Resistor, depos. carbon	1.25 MΩ/0.25 w	WF 1,25 M/0,25
R144	Resistor, depos. carbon	30 kΩ/0.5 w	WF 30 k/0,5
R145	Resistor, depos. carbon, variable	10 kΩ lin.	WS 9122 F/10 k
R146	Resistor, depos. carbon	40 kΩ/0.5 w	WF 40 k/0,5
R147	Resistor, depos. carbon	500 kΩ/0.25 w	WF 500 k/0,25

Ref. No.	Designation	Ratings	R&S Stock No.
R148	Resistor, depos. carbon	1 kΩ/0.25 w	WF 1 k/0,25
R150	Resistor, depos. carbon	800 kΩ/0.5 w	WF 800 k/0,5
R151	Resistor, depos. carbon	1 kΩ/0.25 w	WF 1 k/0,25
R152	Resistor, depos. carbon	1 kΩ/0.25 w	WF 1 k/0,25
R153	Resistor, depos. carbon	50 kΩ/0.5 w	WF 50 k/0,5
R154	Resistor, depos. carbon	200 kΩ/0.5 w	WF 200 k/0,5
R155	Resistor, depos. carbon	600 kΩ/0.5 w	WF 600 k/0,5
R156	Resistor, depos. carbon	100 kΩ/0.5 w	WF 100 k/0,5
R160	Resistor, depos. carbon	800 kΩ/0.5 w	WF 800 k/0,5
R161	Resistor, depos. carbon, variable	25 kΩ lin.	WS 9122 F/25 k
R162	Resistor, depos. carbon	60 kΩ/0.5 w	WF 60 k/0,5
R163	Resistor, depos. carbon	1 MΩ/0.25 w	WF 1 M/0,25
R164	Resistor, depos. carbon	10 kΩ/0.25 w	WF 10 k/0,25
R165	Resistor, depos. carbon	1 MΩ/0.25 w	WF 1 M/0,25
R166	Resistor, depos. carbon	50 kΩ/0.25 w	WF 50 k/0,25
R167	Resistor, depos. carbon	40 kΩ/0.25 w	WF 40 k/0,25
R168	Resistor, depos. carbon	200 kΩ/0.25 w	WF 200 k/0,25
R170	Resistor, depos. carbon	125 kΩ/0.5 w	WF 125 k/0,5
R171	Resistor, depos. carbon, variable	50 kΩ lin.	WS 9122 F/50 k
R172	Resistor, depos. carbon	80 kΩ/0.5 w	WF 80 k/0,5
R173	Resistor, depos. carbon	50 kΩ/0.25 w	WF 50 k/0,25
R174	Resistor, depos. carbon	50 kΩ/0.25 w	WF 50 k/0,25
R175	Resistor, wire-wound	4 Ω/5 w	WD 5/4
R176	Resistor, wire-wound	4 Ω/100 w	WD 100/4
R177	Resistor, wire-wound	2 x 4 kΩ/2 w	2xWD 4 k/2 in series
R178	Resistor, depos. carbon	10 Ω/0.5 w	WF 10/0,5
R179	Resistor, depos. carbon	5 MΩ/0.25 w	WF 5 M/0,25

Ref. No.	Designation	Ratings	R&S Stock No.
R11	Lamp, glow, miniature	220 v	RL 210 B
R12	Lamp, glow, miniature	220 v	RL 210
RsA	Relay		RSS 230041
R81	Triode, twin		E 88 CC
R82	Pentode		EF 93
R83	Pentode		EF 93
R84	Pentode		EF 93
R85	Pentode		EF 93
R86	Pentode		6 BN 6
R87	Pentode		EF 95
R88	Triode, twin		ECC 81
R89	Triode, twin		ECC 81
R810	Triode-pentode		ECF 80
R811	Triode, twin		ECC 81
R812	Triode		E 86 C
R813	Pentode, power		EL 803
R814	Pentode, power		EL 803
R815	Triode, pentode		ECF 80
R816	Triode		EC 92
R817	Pentode		EF 95
R818	Reference tube		85 A 2
R819	Triode, power, twin		6080
R820	Pentode		EF 95
R821	Pentode, output		EL 95
R822	Pentode, output		EL 95
R823	Reference tube		108 C 1

Ref. No.	Designation	Ratings	R&S Stock No.
Si1	Fuse	1 amp	1 C DIN 41571
S1	Switch		incl.in 15221-8/...
S2	Switch, range		incl.in 15221
S3	Switch assembly		SRA 10221
S4	Switch, midget step		SRW 07120
S5	Switch assembly		SRA 10423
S6	Switch, midget step		SRW 07120
S7	Push button		SR 63604
S8	Switch, power		SRK 1
S9	Fuse strip		FD 60515
Tr1	Transformer		15221-56
Tr2	Transformer		15221-7.2
Tr3	Transformer, power		15221-43

Guarantee

Rohde & Schwarz guarantee

FOR ONE YEAR

each instrument manufactured and sold by them to be free from defects in material and workmanship, subject to clause 3 of their terms of delivery and payment.

This guarantee does not imply the right to rescind a sale or demand a reduction in purchase price. The firm's obligation under this guarantee is limited to the repair or replacement of the defective part or parts, provided the claim is asserted in writing immediately, or within one week at the latest, after discovery of the defect. The part or parts shall be returned to the factory, with transportation charges prepaid, within one week from the instruction by the firm to do so. The return charges shall likewise be covered by the purchaser. The firm does not assume any liability for damage resulting directly or indirectly from the defect. The guarantee shall be void if the part or parts have been tampered with.

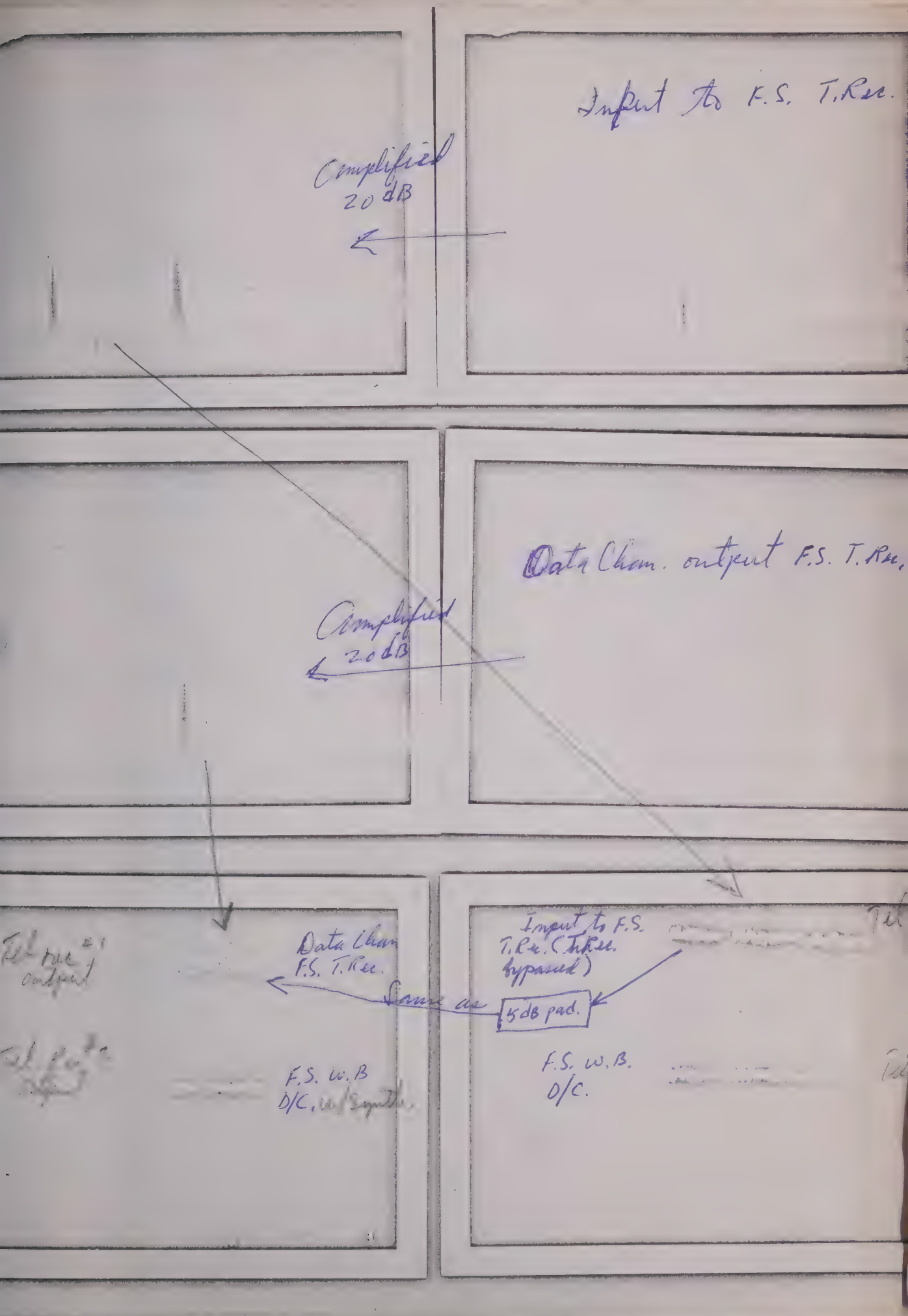
The seals of the instrument shall be undamaged. Rohde & Schwarz guarantee valves for which the purchaser has not received the certificate of guarantee of the manufacturer. Defective valves which are held to be covered by this guarantee shall be returned to the factory for examination. The following details shall be specified:

Number, date and reference of the invoice;

type and serial number (FNr.) of the instrument;

specification of valve defect.

ROHDE & SCHWARZ · MÜNCHEN


Input to F.S. T.Rec.
Amplified 20 dB
Data Chan. output F.S. T.Rec.
Amplified 20 dB
Data Chan F.S. T.Rec.
Input to F.S. T.Rec. (T.Rec. bypassed)
Same as
15 dB pad.
F.S. W.B. D/C, w/ Equalizer
F.S. W.B. D/C.

Accuracy ± 2% of indicated frequency

Frequency indication

10-db steps
Accuracy ± 0.2 db per step

Input attenuator 0-60 db

Automat

Manual

Automatic or manual tuning selectable

Tuning

coarse

fine

Z = 50 Ω or 60 Ω
Min. input voltage 10 μV_{rms}
Max. input voltage 10 V_{rms}

Signal input

7 sub-ranges
30-400 Mc
30-60/50-100/75-150/
110-200/170-270/250-330/
330-400 Mc

Frequency range

>100 Mc, but only in selected band, switch-selected; max. tracking speed 10 Mc/msec, tracking from low to high frequencies

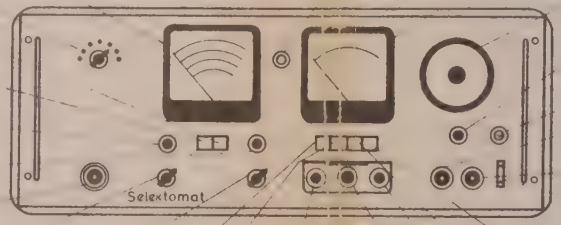
Tracking

log

Log. or lin., switch-selected
log. 0--80 db = 100 mV-10 µV
lin. 0--20 db = 100 µV-10 µV
Accuracy
log. ± 2% of indicated value, but not better than ± 0.5 db
lin. ± 3% of indicated value, but not better than ± 0.1 db

Indication

lin



Gain
adjustable
in METER operation ± 1.5 db
in POLYSKOP operation ± 5 db

"Not tuned" pilot lamp

Lights when no signal is received.

Amplitude indication

Reference-line adjustment

For measurements with the POLYSKOP, continuously adjustable, calibrated in db

Calibrate

In operation with the POLYSKOP for adjusting both amplifiers for equal gain

Pilot lamp

Signal output

Ret. line to Polyskop

Power switch

Polyskop

Indication

Meter

Indication of measured value on panel meter or on POLYSKOP, switch-selected

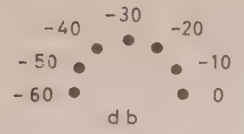
Start of tracking

In automatic operation and swept-frequency measurement adjustment of tracking over full screen width

Calibration voltage

Calibration oscillator at 35 Mc, switch-selected, stability of amplitude ± 2%

Fig. 1 Characteristics of the SELEKTOMAT



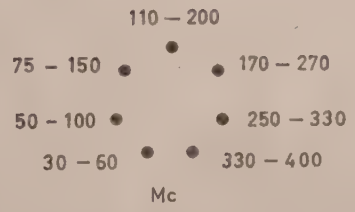
INPUT ATTENUATOR (10-db steps) (24)

MANUAL AUTOMAT. (22/23)

TUNING

COARSE (21)

FINE (20)

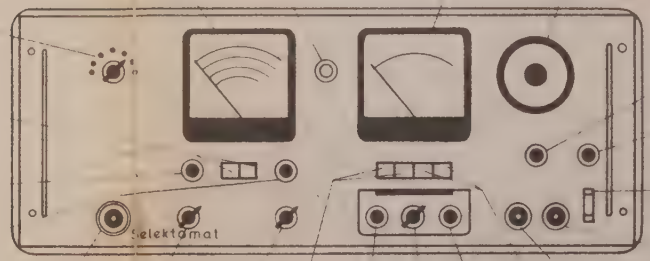


Frequency indication (1)

(2) NOT TUNED pilot lamp

Amplitude indication (3)

(4) Reference-line adjustment



(5) CALIBRATE

(6) Pilot lamp

(7) Power switch

(8) REF. LINE

(19) INPUT

(18) (17) TRACKING

Frequency range

(15/16) (14) GAIN

INDICATION LOG. LIN.

(13) (12) START OF TRACKING

(10/11) (9) SIGNAL OUTPUT

INDICATION Meter POLYSKOP

FIG. 2

FRONT-PANEL CONTROLS

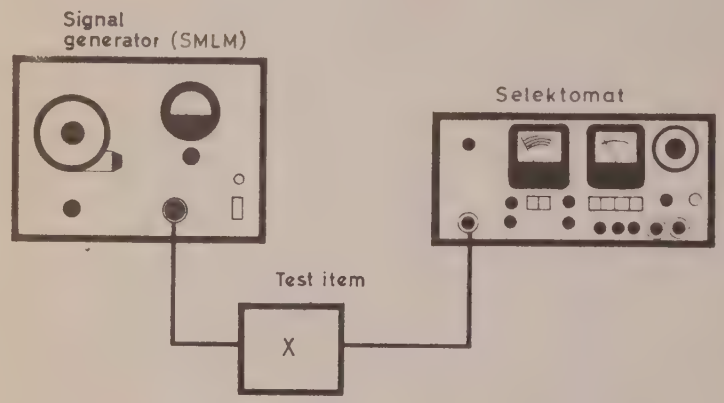


Fig. 3

Point-by-point measurement on a four-terminal network

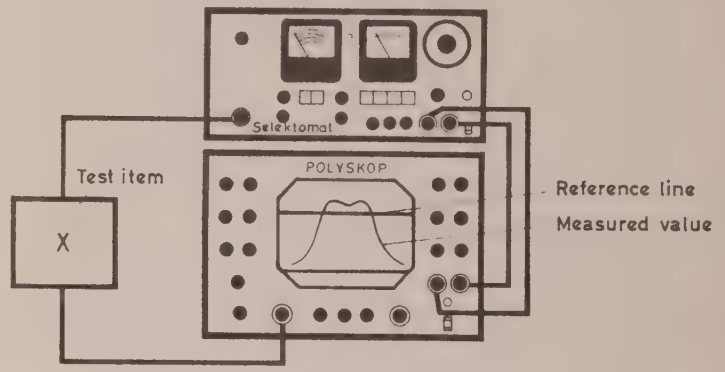


Fig. 4
Frequency-response measurement with the POLYSKOP

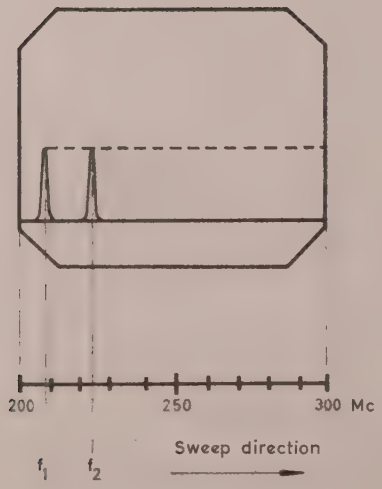


Fig. 5
Swept-frequency measurement

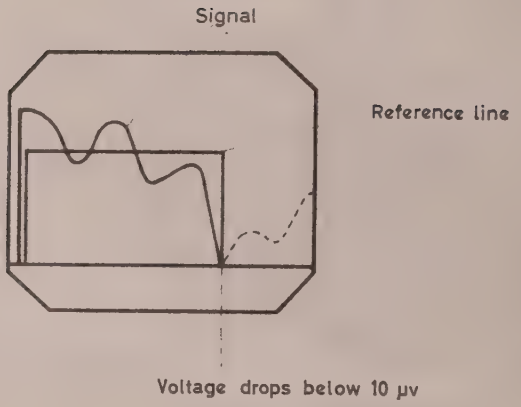


Fig. 6 Failure to track

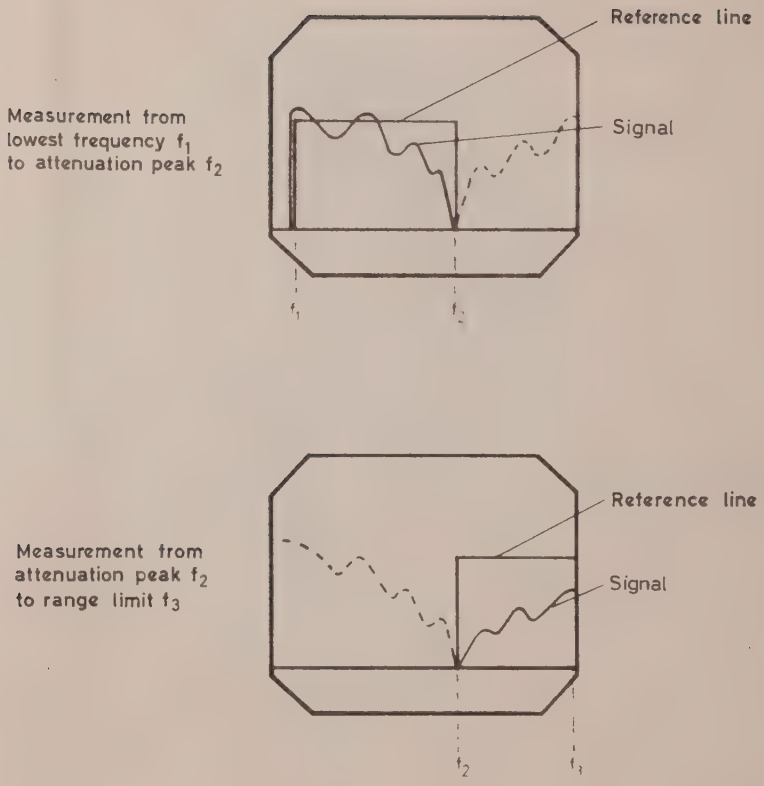


Fig. 7
Measuring method with extreme attenuation peaks present in the measurement range

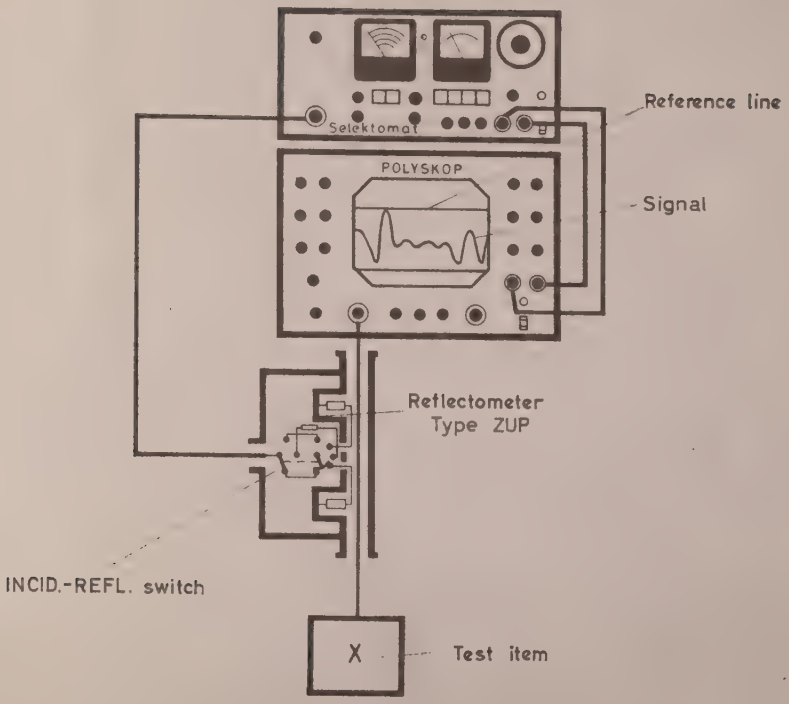


Fig. 8
Measuring reflection coefficients as a function of frequency

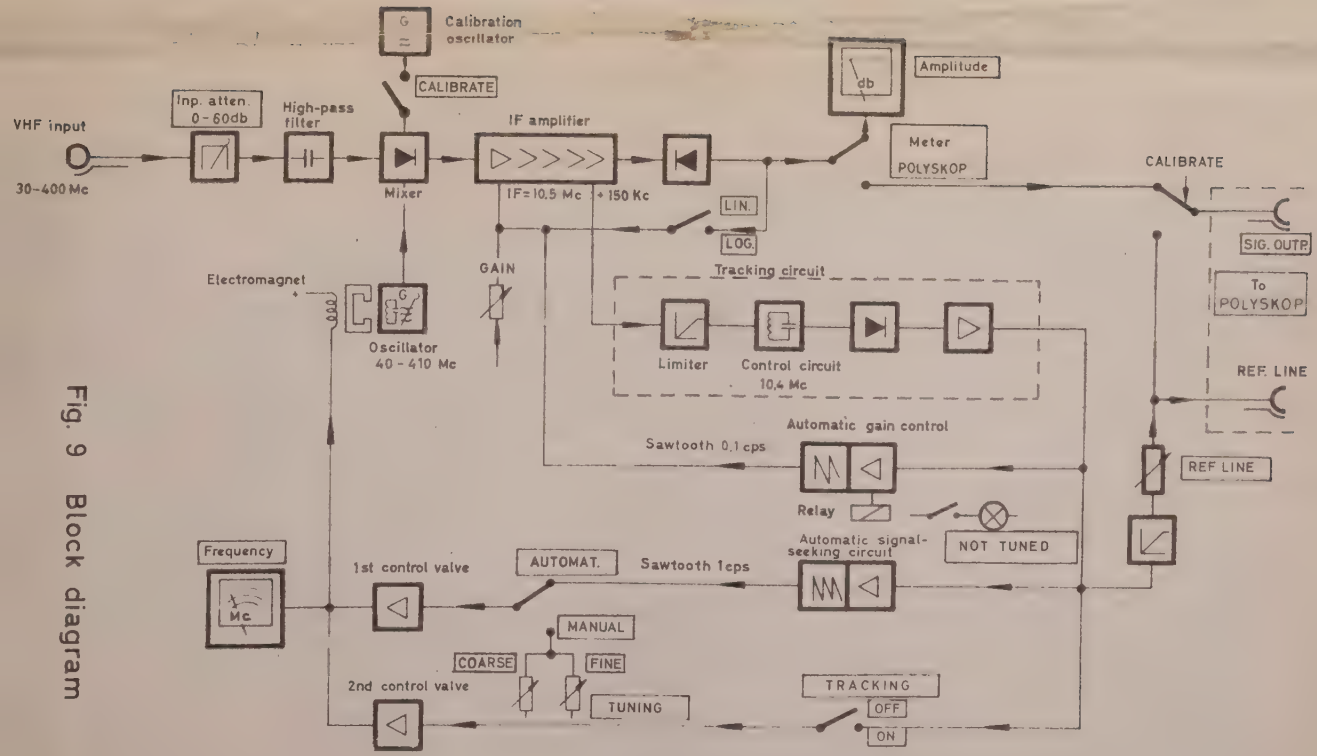


Fig. 9 Block diagram

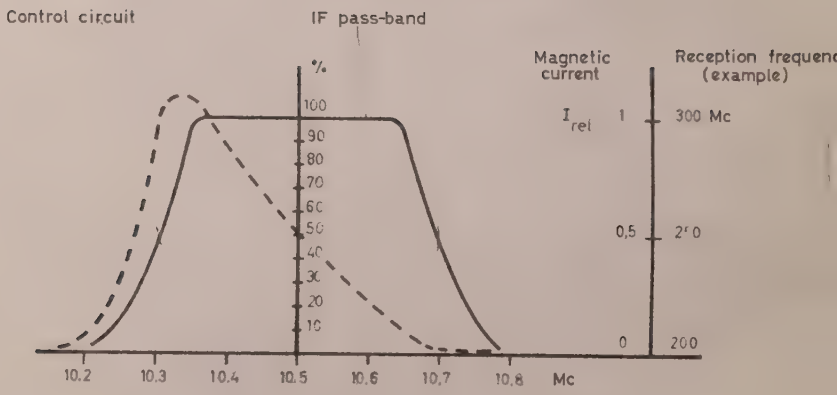


Fig. 10

Pass-band characteristics of the IF amplifier and the control circuit

Fig. 11. RF output voltage of the POLYSKOP

Fig. 12. Voltage curve at the output of the IF amplifier

Fig. 13. Voltage curve at check point ①

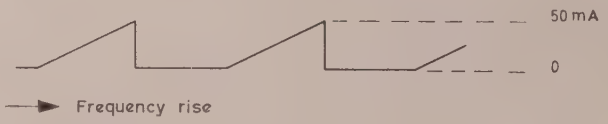


Fig. 14 Current through magnet coil

Fig. 11 to Fig. 14

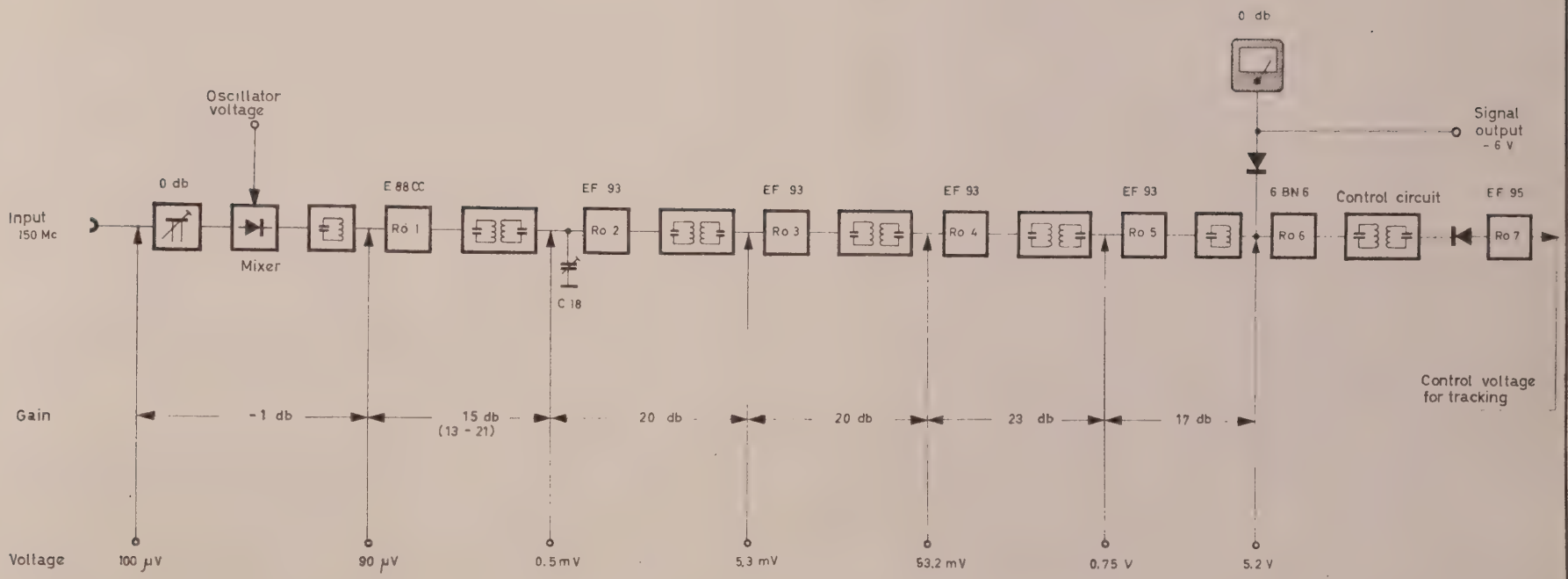
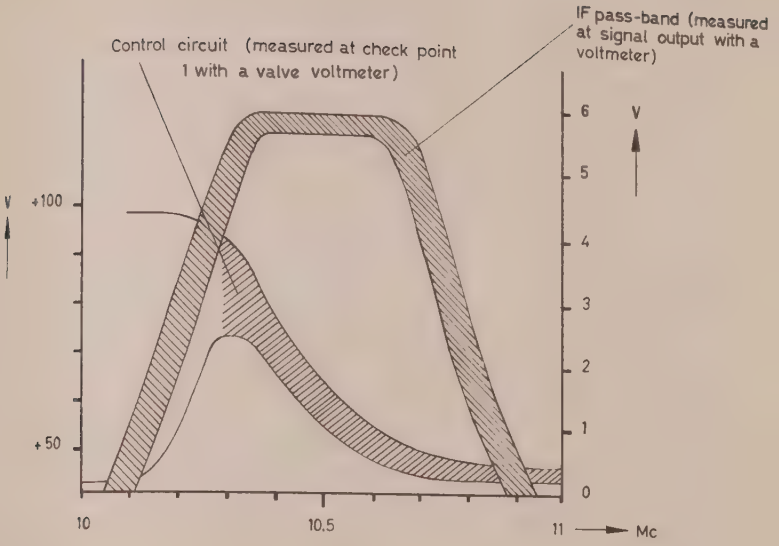


Fig. 15

RF and IF levels in linear operation



Type of operation: LIN., MANUAL, METER,
TRACKING ON, INPUT ATTENUATOR -60 DB

Feeding: R812 withdrawn. Connect signal generator via 100 pf to points 1 and 9 of socket of R812. (frequency 10 to 11 Mc)

Measurement:

1. IF pass band
2. Voltage at check point (1) at normal level
3. Voltage at check point (1) with signal voltage reduced by 20 db

In measurements 2 and 3 these tolerances must be observed.

Fig. 16 IF pass-band and control circuit (tolerances)

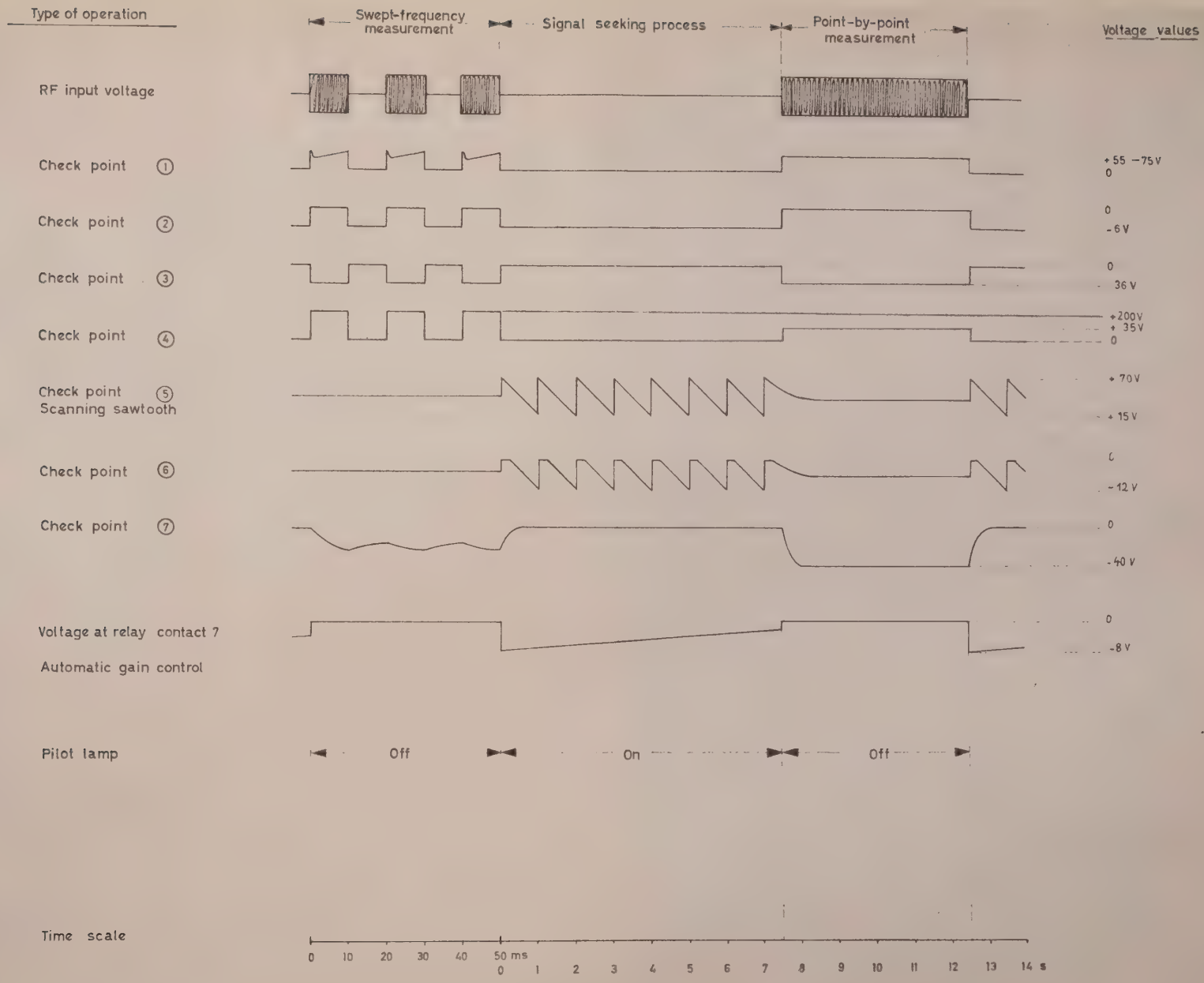
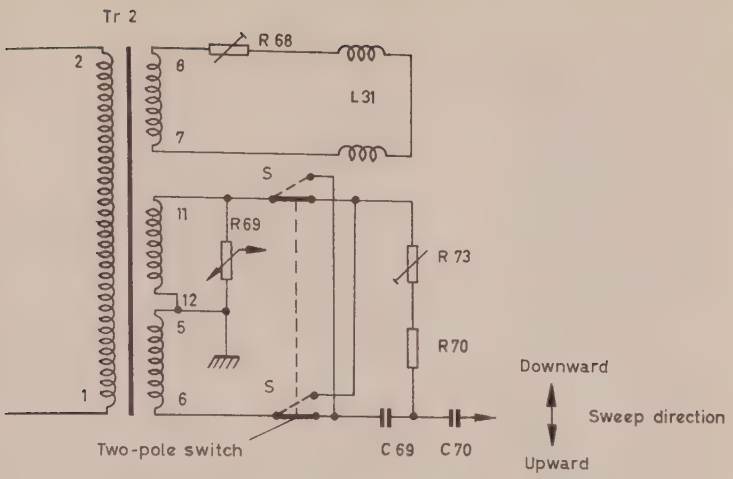
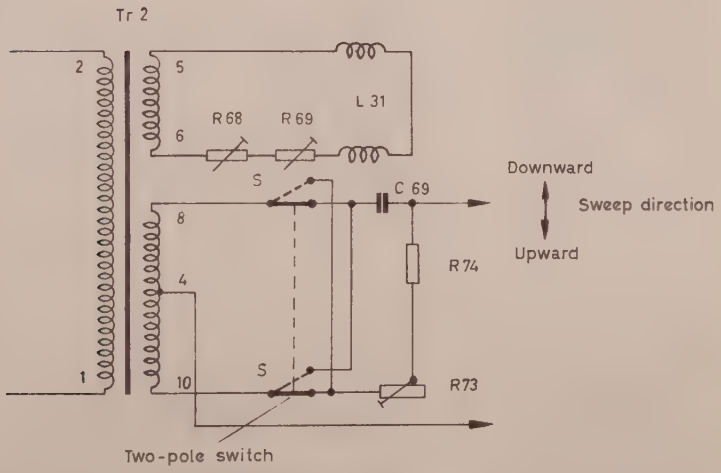


Fig. 17 Voltage values

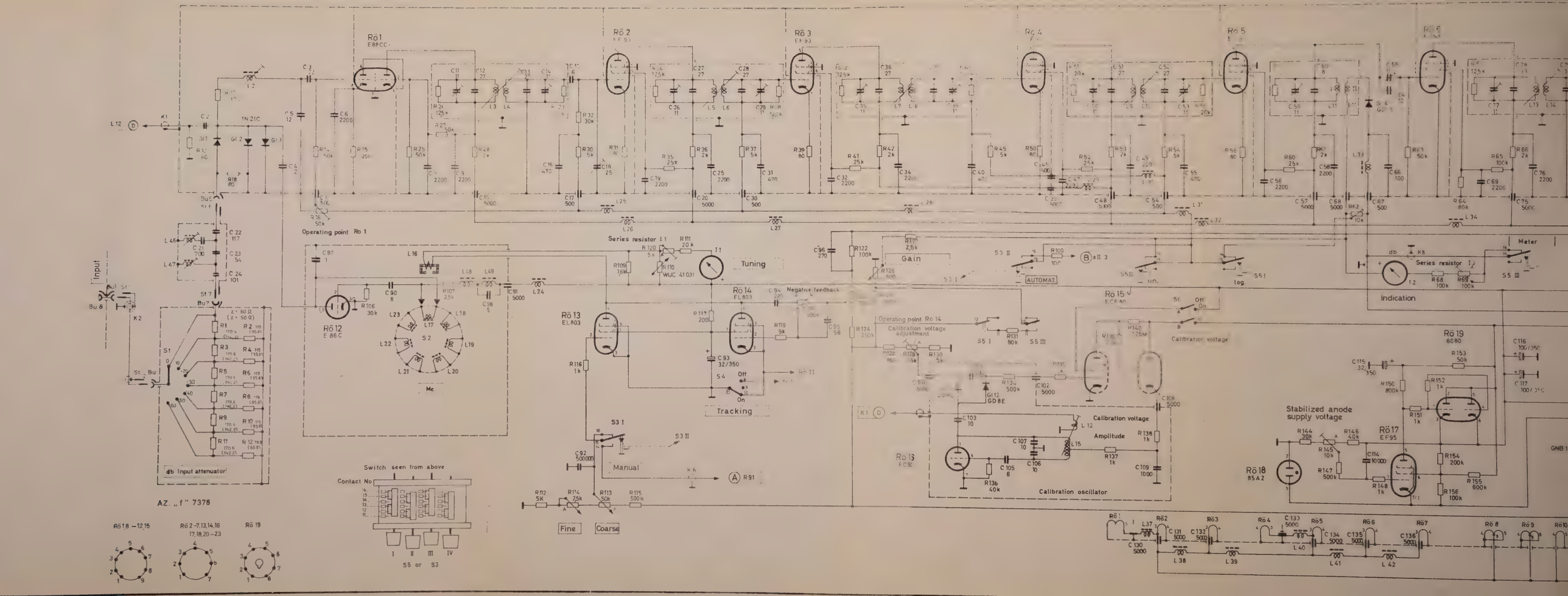


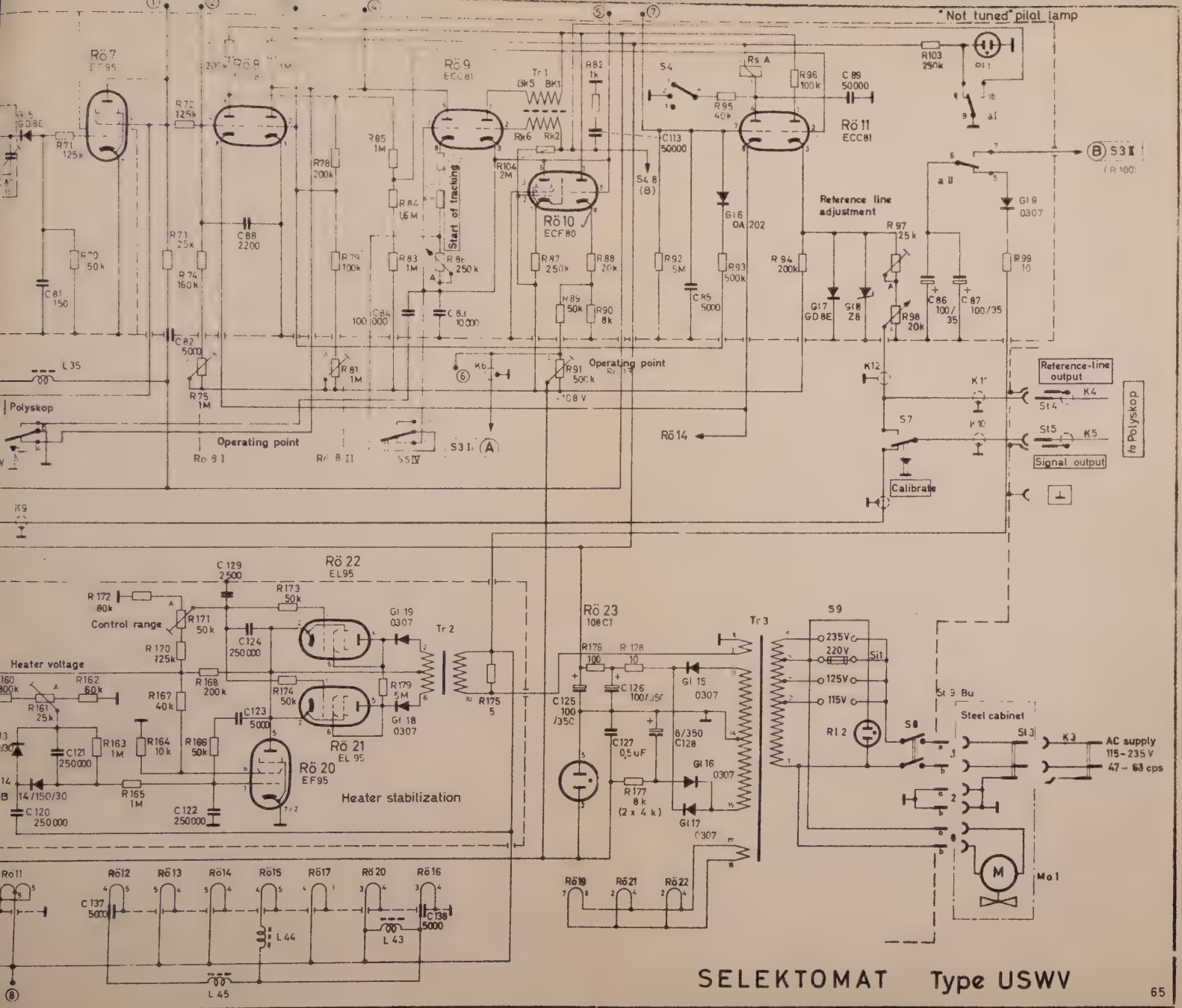
Insertion of a switchover facility for sweep direction into POLYSKOPs with 3-db button

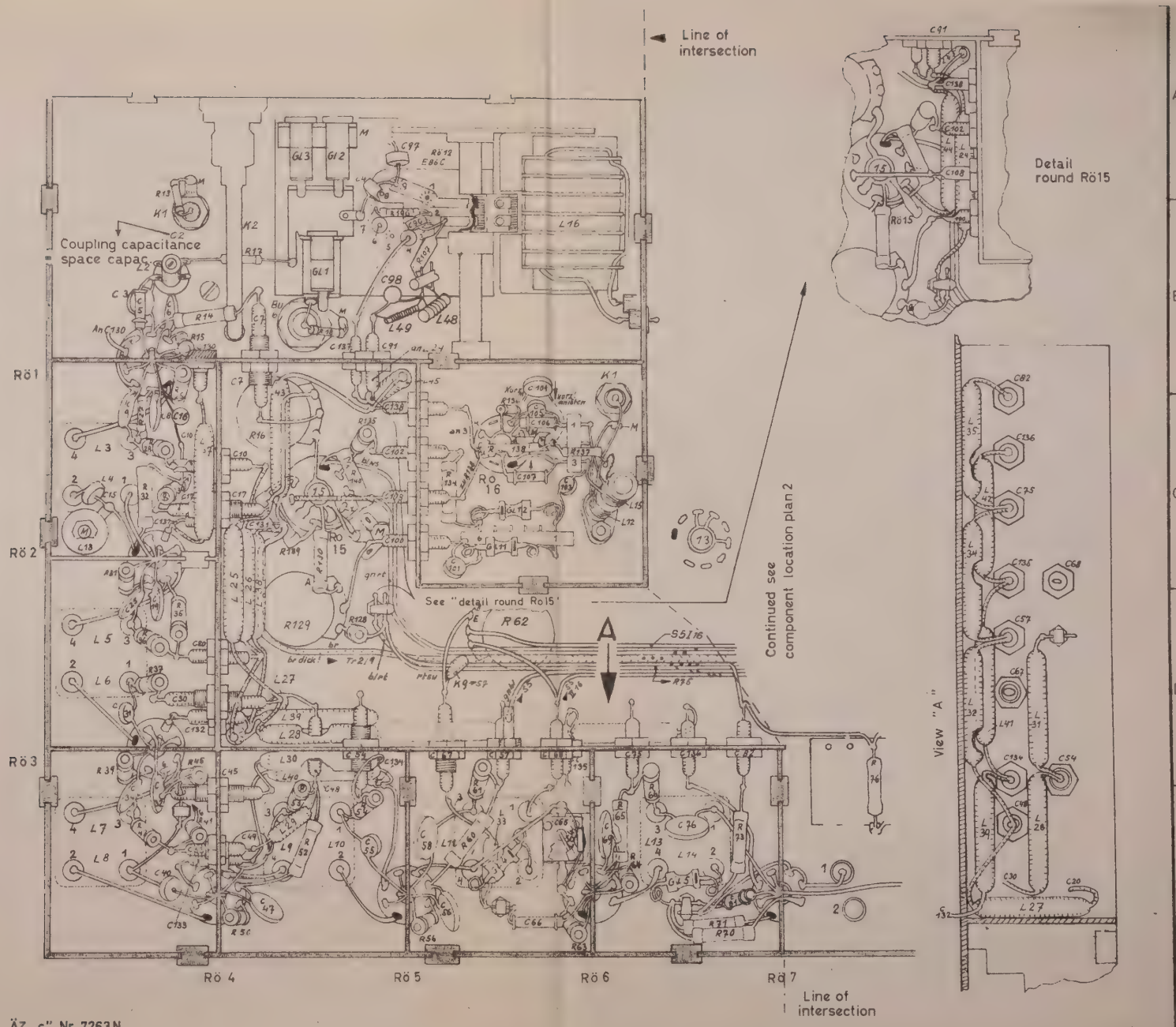


Insertion of a switchover facility for sweep direction into POLYSKOPs with 1-db attenuation

Fig. 18

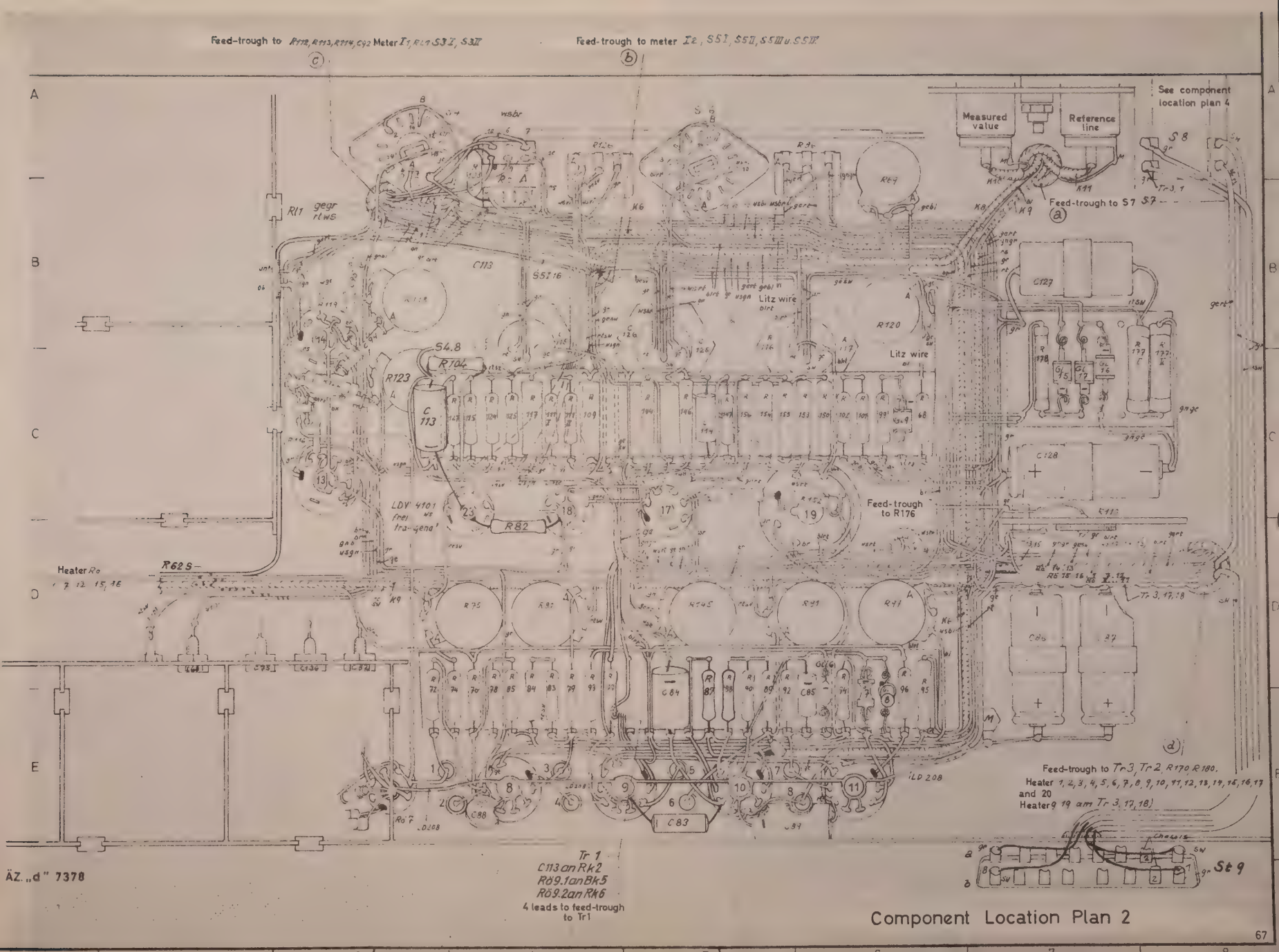

Input
Bu 8
Bu 7
K2
S1
S17
db Input attenuator
AZ. „f" 7378
Rö 1
E 88 CC
Rö 2
Rö 3
Rö 4
Rö 5
Rö 6
Rö 7
Rö 8
Rö 9
Rö 10
Rö 11
Rö 12
E 86 C
Rö 13
ELL 803
Rö 14
EL 803
Rö 15
ECF 80
Rö 16
EC 91
Rö 17
EF 95
Rö 18
85 A 2
Rö 19
6080
1N 21 C
Operating point Rö 1
Series resistor I 1
Tuning
Negative feedback
Gain
Operating point Rö 14
Calibration voltage adjustment
Calibration voltage
Amplitude
Calibration oscillator
Stabilized anode supply voltage
Indication
Meter
Series resistor I 2
Tracking
Manual
Fine
Coarse
Switch seen from above
Contact No
S5 or S3
Rö 1,8 –12,15
Rö 2–7,13,14,16 17,18,20–23
Rö 19

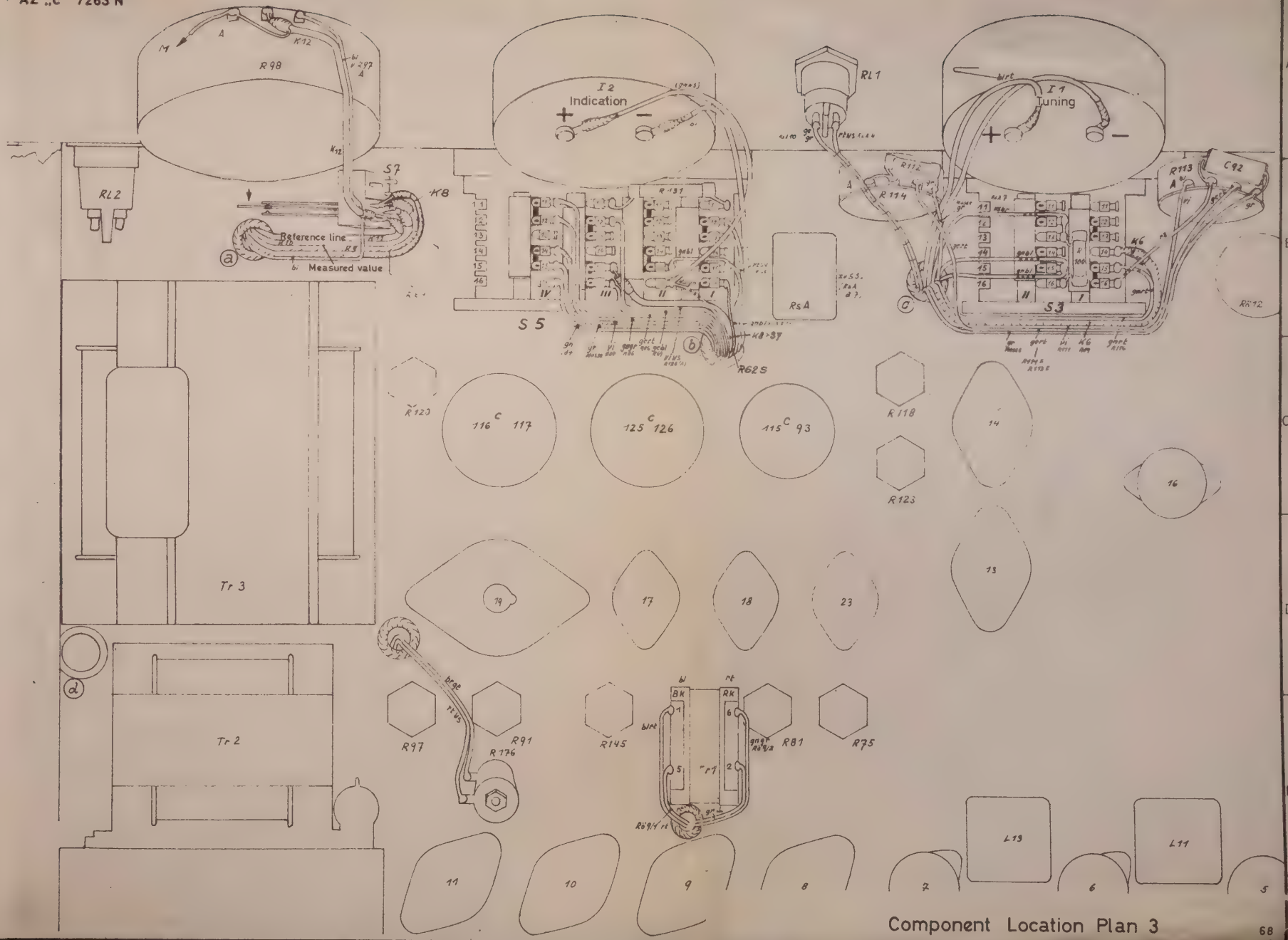

"Not tuned" pilot lamp
Rö 7
EF95
Rö 8
Rö 9
ECC81
Rö 10
ECF80
Rö 11
ECC81
Rö 14
Rö 22
EL95
Rö 23
108C1
Rö 21
EL 95
Rö 20
EF95
Heater stabilization
Control range
Heater voltage
Operating point
Start of tracking
Reference line adjustment
Reference-line output
Signal output
Calibrate
Polyskop
to Polyskop
Steel cabinet
AC supply
115 – 235 V
47 – 63 cps
SELEKTOMAT Type USWV
65



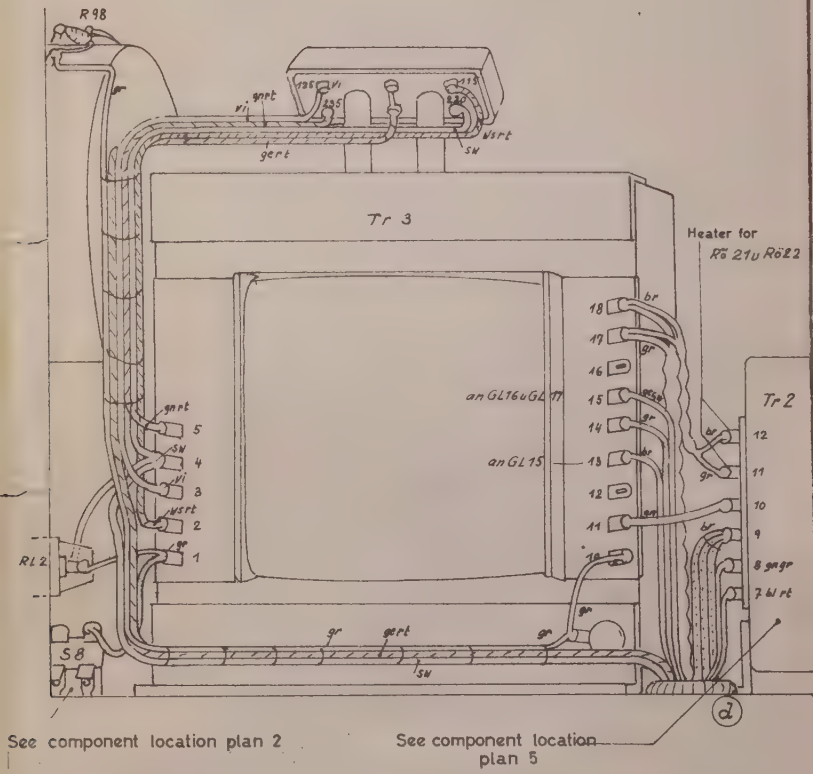
ÄZ „c" Nr. 7263N

Component Location Plan 1


Feed-trough to R118, R113, R114, C92 Meter I1, R119 S3I, S3II
Feed-trough to meter I2, S5I, S5II, S5III u. S5IV
See component location plan 4
Measured value
Reference line
Feed-trough to S7
S7
S8
R117 gegr rlws
C113
S5I 16
Litz wire
R120
S4.8
R104
R123
C 113
LDV 4101 frei tra-gena'
R82
Feed-trough to R176
Heater Ro
R62 S
C128
C127
C84
C85
C83
C88
C95
C136
C94
Tr 1
C113 an Rk2
R69.1 an Bk5
R69.2 an Rk6
4 leads to feed-trough to Tr1
Feed-trough to Tr3, Tr2, R170, R180.
Heater 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 20
Heater 9 19 am Tr 3, 17, 18)
Chassis
St 9
ÄZ. „d" 7378
Component Location Plan 2
67



Component Location Plan 3

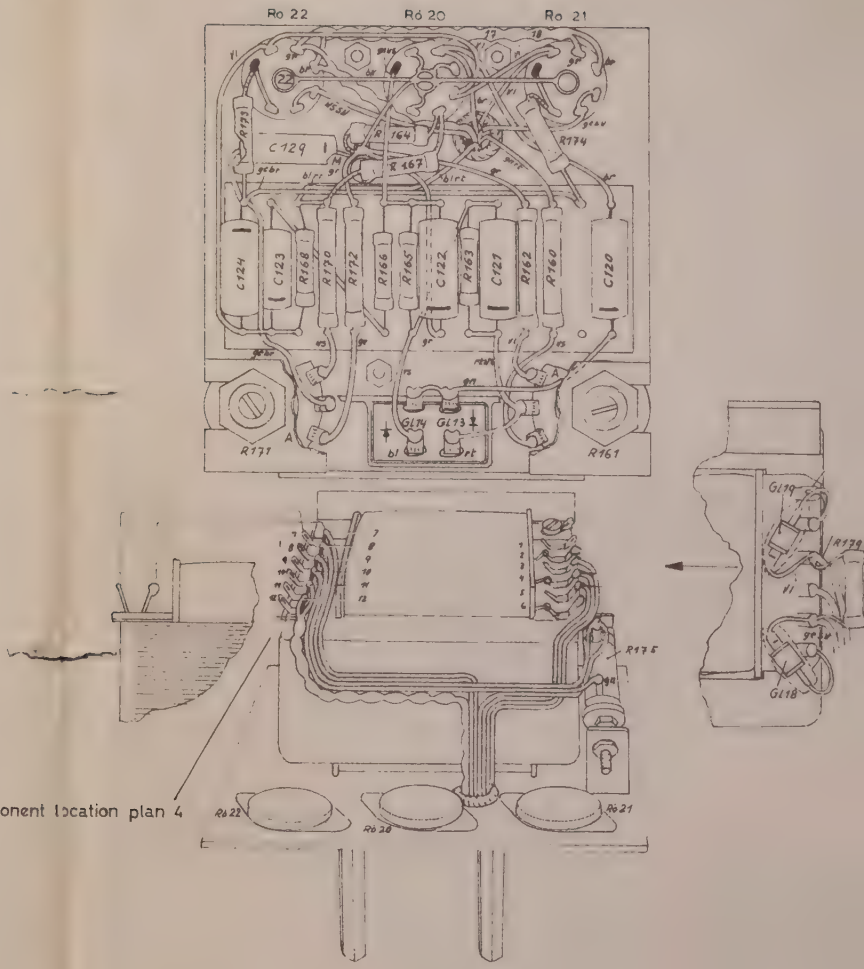


ÄZ, 28.7.60

Selektomat
(15221 P)

R 7493
961
Bl. 69

Component Location Plan 4

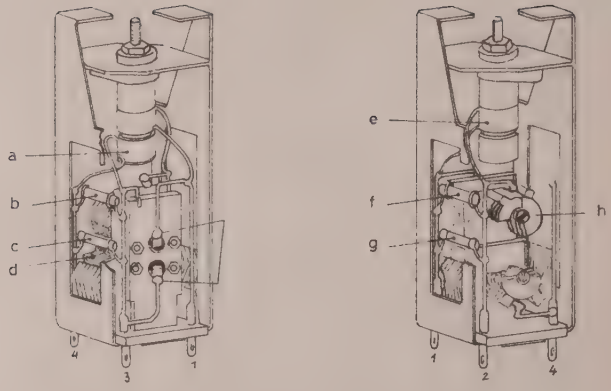


See component location plan 4

'AZ „b" Nr. 7010

Heater regulation
(15221-7P)

Component Location Plan 5

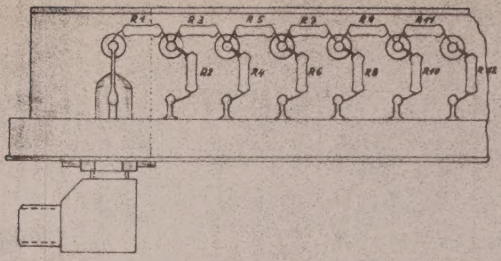


	a	b	c	d	e	f	g	h
15221-18	L3	C12	R26	C11	L4	C13	R29	C14
15221-19	L5	C27	R34	C26	L6	C28	R38	C29
15221-20	L7	C36	R40	C35	L8	C37	R43	C38
15221-21	L9	C51	R51	C50	L10	C52	R55	C53
15221-23	L13	C78	R67	C77	L14	C79	—	C80

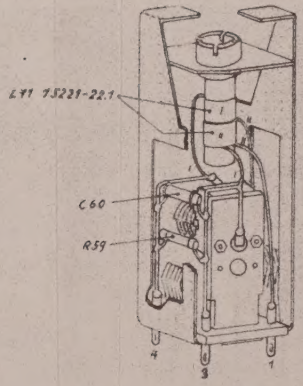
ÄZ „b" Nr. 7378

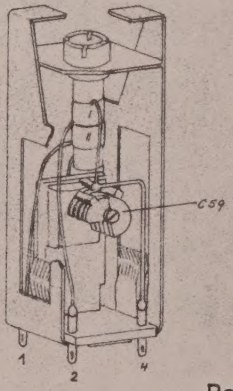
Band-pass filter
(15221-18P)

Component Location Plan 6

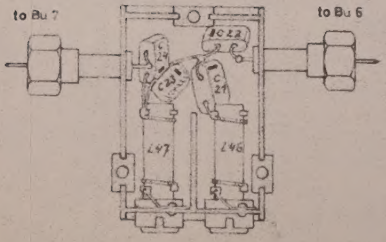


Attenuator
(15221-8P)





Band-pass filter
(15221-22P)



High-pass filter
(15221-48P)

Component Location Plan 7, 8 and 9